MÉMOIRES

ET

COMPTES RENDUS

DE LA

SOCIÉTÉ ROYALE

DU

CANADA

POUR L'ANNÉE 1886.

TOME IV.

MONTRÉAL:
DAWSON FRÈRES, LIBRAIRES-ÉDITEURS.
1887.

PROCEEDINGS

AND

TRANSACTIONS

OF THE

ROYAL SOCIETY

OF

CANADA

FOR THE YEAR 1886.

VOLUME IV.

NEWPORT
NATURAL HISTORY
SOCIETY.
INCORPORATED 1883.

MONTREAL:
DAWSON BROTHERS, PUBLISHERS.
1887.

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ROYAL SOCIETY OF CANADA.

PROCEEDINGS FOR 1886.

FIFTH GENERAL MEETING, MAY, 1886.

SESSION I. (*May 25th.*)

The Royal Society of Canada held its fifth general meeting in the Railway Committee room, Parliament Buildings, Ottawa, on Tuesday, May 25th. The President, Dr. Daniel Wilson, took the chair at 11 o'clock a.m., and formally called the meeting to order.

The Honorary Secretary then read the following

REPORT OF COUNCIL.

The Council have the honour to submit their Annual Report.

In the month of May last, the Council appointed the following gentlemen as members of the Printing Committee, viz., Drs. T. Sterry Hunt and Daniel Wilson, Sir William Dawson, Prof. Alex. Johnson, Drs. Fréchette and Chauveau, and Mr. Thos. Macfarlane, of whom three should constitute a quorum.

The following Report of the Printing Committee has been submitted to the Council:—

"The Printing Committee have to report the publication of the third volume of the Proceedings and Transactions of the Royal Society of Canada, which appeared May 22nd, and contains 640 pages of text (being a little larger than the report last year), and not less than thirteen pages of maps and plates. They would note also the great number of pages of tabulated figures in the paper on the Longitude of Montreal, the printing of which necessarily caused much additional expense and considerable delay. Still farther delays have been caused by the great amount of alteration made by some writers in their proof-sheets, and by their remissness in many cases in returning these sheets. The Committee, under all these circumstances, have reason for congratulation in the fact that their task is completed before the Annual Meeting, and that copies of the volume are now in the hands of the Society. Their thanks are due for the many courtesies shown by the publishers Messrs. Dawson Bros. of Montreal, and to Mr. R. W. Boodle, the acting editor, for his skill, care and efficient services.

"They call attention to the fact that of the Report on Fellowships, etc., which forms an Appendix of fourteen pages to the Proceedings of this year, 750 copies, printed apart, have already been distributed to the members of the Society, to Universities, learned societies, and others interested.

"The Committee would earnestly recommend to all the members of the Society greater care in the preparation of their papers for publication. No paper should be sent to the Secretaries until it is

in a completed state and ready for printing, without farther additions. They would also urge that papers should be sent in without delay, in order that printing might commence at once, and would recommend that August 1st be fixed as a date at which all matter should be in the hands of the Printing Committee, and after which no more can be received.

"They have got from the publishers a statement herewith appended of the number of copies of the Volumes I and II, now on hand, amounting to 298 copies of Vol. I, and 327 copies of Vol. II.

"The accounts of the Society with the publishers, up to May 22nd, have been received and are herewith submitted."

MONTREAL, May 22nd, 1886.

The Royal Society of Canada.

To Dawson Brothers, Dr.

For Balance as per last account		$ 288 53
Account of editing		327 00
Foreign and domestic freight, express charges on deliveries		331 61
Stationery		3 75
Cases, packing, shipping expenses		85 90
Binding of extra copies		28 50
Expenses of committees		144 00
Paper		1,391 25
Postages, proofs		58 37
Illustrations		420 00
Composition		1,606 53
Press work		303 50
Cancelled matter		50 00
Alterations from copy		280 57
		$5,319 51
By Cash	$ 235 00	
" "	328 00	
" "	200 00	
" "	800 00	
" "	403 87	
" "	2,227 48	
		4,194 35
		$1,125 16

A special copy of the Transactions for the year 1884 was forwarded to Her Majesty the Queen, through His Excellency the Governor-General, and the following acknowledgment duly received :—

OTTAWA, April 19, 1886.

J. G. BOURINOT, *Esq., Clerk of the House of Commons, &c.:*

SIR,—I have the honour to forward to you herewith a copy of a despatch from the Colonial Office, acknowledging the receipt of a copy of the Transactions of the Royal Society of Canada for the year 1884, and conveying Her Majesty's thanks to the Society.

I have the honour to be, Sir, your obedient servant,

HENRY STREATFIELD,

Governor-General's Secretary.

[COPY.]

DOWNING STREET, March 26, 1886.

Governor-General the Most Hon. the MARQUESS OF LANSDOWNE, G. C. M. G., *&c.:*

MY LORD,—I have received and laid before the Queen your Lordship's despatch, No. 50, of the 23rd ult., forwarding for Her Majesty's acceptance a copy of the Transactions of the Royal Society of Canada, for the year 1884, and I am commanded to convey to the Society, through your Lordship, Her Majesty's thanks for the volume.

I have, etc.,

(Signed) GRANVILLE.

The Honorary Secretary communicated to Professor Bonney, the distinguished President of the Geological Society of London, the fact of his having been unanimously elected one of the Corresponding Members of the Royal Society, and subsequently received the following letter of acceptance:—

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE,

22 Albemarle St., LONDON, W., June 18, 1885.

To J. G. BOURINOT, *Esq., Hon.-Sec. Roy. Soc. Canada:*

SIR,—Your letter of June 2nd, announcing my election as a Corresponding Member of the Royal Society of Canada, has caused me no less surprise than pleasure. I should not have deemed myself worthy of so high an honour, and shall regard it as an incentive to render myself worthy of the confidence which your members have reposed in me. Pray convey to them my sincere thanks, and express my sense of obligation.

I remain, Sir, yours faithfully,

T. G. BONNEY.

During the past winter the Council had the honour of an interview with the Premier and other members of the Government of Canada, and urged on them the desirability of continuing the grant of $5,000 which the Society has received for the last three years. Several members of the Council addressed the Ministers on the subject, and the Premier replied in very satisfactory terms, expressing his approval of the work already done by the Society, and his own opinion that it was deserving of financial assistance. He promised to bring the matter to the attention of his colleagues, and at his suggestion the Council addressed a memorial to the Governor-General, setting forth the objects and labors of the Society and formally praying for a renewal of the grant. We are happy to be able to state that the Government has placed the sum in the Estimates, and we have every confidence that Parliament will approve the recommendation and pass the vote in due form.

The Council have continued to coöperate with the British Association in pressing on the Canadian Government the importance of publishing Tide Tables, and the necessity of establishing for this purpose stations for continuous Tidal Observations in the waters of the Dominion. A large delegation, composed of members of the Royal Society, of the Committee appointed by the British Association, and of the Board of Trade of Montreal, waited on the Minister of Marine and Fisheries in January last, and gave him full explanations on a subject of such great interest to the commerce and marine of Canada. At a subsequent interview, on the same day, with the Premier and other members of the Cabinet, arguments were advanced in favour of the scheme, and information given on practical points connected with the proposed observations. It is satisfactory to know that the members of the Government appeared to approve of the propositions submitted to them, but in consequence of the expenditures entailed by the surveys of Georgian Bay and by the expeditions to Hudson Bay, they have been unable, so far, to recommend a vote to Parliament. The deputation, however,

felt encouraged by the interview, and there is much reason for coming to the conclusion that no long time can pass before the Government will take the matter into their earnest and favourable consideration. Under these circumstances, the Council recommend that the Royal Society continue to press on the Government and the Parliament of Canada the importance of these Observations.

In accordance with the regulations of the Royal Society, invitations were issued by the Honorary Secretary to the leading literary and scientific societies of Canada, asking them to send delegates to take part in all general and sectional meetings for the reading and discussion of papers, and to communicate statements of the work done by their respective associations. It is gratifying to find that the responses to these invitations have been most cordial, and we shall have an average attendance of representatives of bodies who are doing a most useful work throughout the Dominion. The Transactions for the past two years contain summaries of the labours and investigations of these societies, which will be very interesting to all those wishing information as to the intellectual development of this country. The Council believe that in thus coöperating with all the kindred societies throughout the Dominion, the Royal Society is performing a work which is eminently satisfactory, since it enables a number of persons to meet together from all parts of Canada, and compare notes of literary and scientific progress in its different Sections. The Royal Society is not exclusive, but is intended to be thoroughly national and representative in its object and scope.

The following is a list of the Societies which have appointed delegates to this Annual Meeting: —

List of Delegates from Affiliated Societies.

1. Numismatic and Antiquarian Society of Montreal.—*W. D. Lighthall.*
2. Historical Society, Winnipeg.—*Rev. Dr. G. Bryce.*
3. Entomological Society of Ontario.—*W. H. Harrington.*
4. Literary and Historical Society of Quebec.—*Dr. J. M. Harper.*
5. Natural History Society of Montreal.—*A. H. Mason.*
6. Nova Scotia Historical Society.—*Rev. Dr. J. Forrest.*
7. Natural History Society of St. John, N.B.—*J. A. Estey.*
8. Institut Canadien, Ottawa.—*F. R. E. Campeau.*
9. Société Historique de Montréal.—*A. Garneau.*
10. Ottawa Literary and Scientific Society.—*W. P. Anderson.*
11. Canadian Institute, Toronto.—*Prof. W. H. Ellis.*
12. Institut Canadien de Québec.—*J. J. T. Frémont.*
13. Geographical Society of Quebec.—*H. J. J. B. Chouinard.*
14. Ottawa Field Naturalists' Club.—*R. B. Whyte.*
15. Nova Scotian Institute of Natural Science.—*A. H. MacKay* (substitute, *Maynard Bowman*).
16. Murchison Society of Belleville.—*Thos. Wills.*
17. Hamilton Association.—*T. C. Keefer.*

The necessity of a stricter compliance with the rule that requires members to send in titles and abstracts of papers, at least three weeks before the day of the Annual General Meeting, is urged by the Council in view of the great advantages that all the members derive from being made cognisant in time of the subjects that are to be discussed in the Sections. For the first time this year, the Honorary Secretary published the titles and abstracts so far as he had received them, and forwarded them by mail to the members of the Society. But it will be seen that the rule has been observed in only a few cases. It is also necessary to state that members should make their abstracts as brief as possible. In one or two cases the matter was altogether too full for publication.

It is satisfactory to know that the volumes of the Transactions which have been sent to other

countries have met with a very favourable reception, and that a large number of publications are now received in the course of the year from foreign societies. So far, on account of the Royal Society's having no place for a library, the value of these exchanges is in a great measure lost to the members and other persons who may be desirous of consulting these scientific and literary publications. In view of this fact, the Society should, as soon as possible, take into its serious consideration the necessity of making provision for suitable rooms where the members can meet as occasion requires. It is hoped that in the event of the Government of the Dominion erecting at some future time a suitable building for a National Museum in Ottawa, it will be possible to procure from them the accommodation required by the Society.

The Council think it advisable to call attention to the difficulty that arises of obtaining a large attendance of members of the Society at the Annual General Meetings. The average attendance for four years has not exceeded forty-five out of a total membership of eighty Fellows. This year, the Colonial and Indian Exhibition has naturally attracted to England a number of gentlemen who have taken an active part in the proceedings of the Society. In asking the attention of the Society to this subject, the Council would at the same time refer specially to the rule which sets forth, that "Any member failing to attend three years in succession, without presenting a paper, or assigning reasons in writing satisfactory to the Society, shall be considered to have resigned." The attention that was called to this rule at the Annual General Meeting of 1885, has produced a good effect, since it has induced several members to take a more active interest in the work of the Society, by sending papers, which will be found of considerable interest and value. In this connection, the Council regret to state that Mr. Charles Sangster has sent in a formal resignation of his membership in Section II, on account of the condition of his health, which prevents him from taking an active part in the work of the Society. Under these circumstances, the Council would recommend that Mr. Sangster's resignation be accepted.

Some doubts having arisen as to the interpretation to be placed on Rule 6, providing for the election of new members, the Council would recommend that the second paragraph of the Rule be rescinded, and the following substituted therefor:—

"The number of members in each section shall be limited to twenty. Any vacancy occurring in any Section shall be reported to the Secretary of that Section by the Honorary Secretary, as early as possible. The Section shall proceed at the time of the Annual General Meeting to nominate by ballot for the filling of such vacancy, The nominations, with reasons stated in writing, shall then be transmitted to the Council, and by it submitted for final vote to the Society at its General Meeting of the ensuing year."

List of Members Present.

The Honorary Secretary called over the roll of members, and the following gentlemen responded to their names:—

Dr. Daniel Wilson, Very Rev. T. E. Hamel, Sir W. Dawson, Dr. T. Sterry Hunt, J. G. Bourinot, G. T. Denison, Prof. Chapman, A. Lusignan, Dr. R. Bell, J. M. LeMoine, P. Lemay, F. N. Gisborne, W. Kirby, Abbé Tanguay, A. D. DeCelles, T. Macfarlane, G. Stewart, Jun., Dr. J. A. Grant, C. H. Carpmael, Dr. Sandford Fleming, Dr. G. M. Dawson, G. C. Hoffmann, J. F. Whiteaves, Dr. Withrow, Prof. Bailey, Dr. Æneas Dawson, John Reade, Prof. J. A. K. Laflamme, J. Fletcher, Dr. Fortin, B. Sulte, J. Tassé.

Business.

The minutes of the Fourth General Meeting, May, 1885, as printed in the third Volume of the Transactions, were read and approved.

The resignation of Mr. Sangster, as a member of Section II, was accepted in accordance with the recommendation of the Council.

The draft of Rule 6, as amended by the Council in their Report, was then considered, and formally adopted *nem. con.*

Reports from Affiliated Societies.

The Honorary Secretary then again read the list of delegates, and the following Reports were submitted from the Affiliated Societies:—

I.—From the Numismatic and Antiquarian Society of Montreal, through Mr. W. D. Lighthall:—

Our Society, though the word "Numismatic" stands before "Antiquarian" in its title, pursues chiefly antiquarian work. It was incorporated in 1869, and holds meetings once a month, from November to April. During the last two years, great advantage has been found in holding the meetings at members' residences, where the Society has been greatly instructed by the view of private collections and unique objects, with which it would have been otherwise impossible for the whole to become acquainted, and the sociable atmosphere of such receptions has contributed greatly to the free communication of ideas; while the young men in particular have been attracted by this means to increased interest in the objects of the Society, which they see so happily pursued in the private life of their elders.

The following papers have been read during the past session:—

Nov. 17. Château Boisbriant, by Mr. R. Lyman.
The Glastonbury Penny, by Mr. R. W. McLachlan.
Dec. 15. Meanderings in History, by Mr. Henry Mott.
Jan. 15. Notes on the Conseil Souverain, by Hon. P. J. O. Chauveau.
Feb. 16. Old Edinburgh and its Associations, by Mr. J. H. Bowe.
March 16. The Louisbourg Medals, by Mr. R. W. McLachlan.
April 15. The Old Parish Churches of the Province of Quebec, by Mr. W. D. Lighthall.

Besides the holding of these meetings, our work includes the support and publication of the *Canadian Antiquarian and Numismatic Journal*, and the gathering together of a collection of coins and other objects, which is kept by one of the officers. We also endeavor, where possible, to protect and preserve "the ancient landmarks," and to prosecute and encourage antiquarian work of all kinds in our neighborhood.

For instance, it is almost certain that the old Church of Notre Dame de Bonsecours, nearly the sole remaining public relic of consequence in Montreal, was saved from absolute demolition by the efforts of the Society, though very painful alterations have been made. Nor is it likely that several books treating of interesting matters would have seen the light of publication had the Society not been steadily doing its duty—such, for example, as the "History of Montreal Jail and the Prison Records," by the Rev. John Borthwick, Chaplain, which is just appearing.

Among our members, Mr. Henry Mott is bringing out an admirable "History of Montreal;" Mr. Charles T. Hart is gathering a large, unique and invaluable collection of photographs of old localities and buildings, chiefly old parish churches, which are fast disappearing. Mr. Roswell Lyman is adding industriously to the accurate sketching and measurement of antiquarian structures and articles. The Society is, in fact, turning its attention strongly to the importance of registering the actual mould and impress of historic things by pictorial means, and its suggestions have moved several outside painters who have reproduced in color such objects as the Bonsecours Church above mentioned, before alteration, and the homestead of La Salle, on the Fraser Farm, at Lower Lachine, the latter of which was exhibited at the Spring Exhibition of the Royal Academy at Montreal. A

little has been done, likewise, in the way of taking heel-ball impressions from monumental inscriptions. The writer would take this opportunity to recommend that some one should undertake a set of the more interesting Canadian inscriptions, of which there are many of value in the churches and graveyards. The process is the simple one of laying a piece of white "lining-paper" (which any wall-paper dealer sells) over the inscription and rubbing across the surface with shoemaker's heel-ball. Indeed, to make a broad suggestion, every family ought to possess a set of these simple records pertaining to itself. I shall close my sketch of our year's work by adding that material is being collected by our Secretary, Mr. Bowe, for a projected description of the coats-of-arms of French Canadian seigniorial families.

II.—From the Literary and Historical Society of Quebec, through Dr. John Harper:—

As I predicted last year, in making my report as delegate from the Literary and Historical Society of Quebec to the Royal Society of Canada, the efforts of our President, George Stewart, Jun., to place our Society more directly in line with the literary activity of to-day have been attended by the most favorable results. A greater interest has been taken in the various departments of our work, and in none more so than in the reading of papers and in the arrangements for a course of lectures. The latter particularly have been a great success, the various lecturers having been greeted by large audiences, consisting of the members of the Society and the citizens of Quebec. Though our finances are not altogether yet in a sufficiently flourishing condition to enable the Society to resume its work of publishing papers and original documents, arrangements were made whereby a printed Report of our Transactions has been issued; and in the name of the Society, I have much pleasure in presenting the Council of the Royal Society with a copy of this Report, wherein will be found the record of the Society's proceedings for the past three years, and a reprint of the "Histoire du Canada," by Abbé de Belmont—a memoir which was first published by our Society in 1840 from the original MS. in the Bibliothéque du Roi at Paris. The various papers and lectures which have been received by the Society, as may be seen from the printed Report, are as follows:—

Nov. 19. The Administration of de Denonville and the Second Term of Frontenac: Inaugural Address, by the President, Dr. Stewart.
Dec. 3. A Year's Experience among the Eskimos in Hudson Strait, by Mr. W. A. Ashe.
Dec. 11. Burmah and the Indo-China Territory in its connection with the Canadian Pacific Railway, by Lieut.-Col. W. Rhodes.
Dec. 18. Impressions de voyage, sir Walter Scott, sa carrière, ses écrits, son château d'Abbotsford, by Mr. J. M. LeMoine.
Dec. 30. Une course dans le nord de l'Afrique, by the Hon. Justice Routhier.
Jan. 29. Quebec and Literature, by Dr. John M. Harper.
Feb. 12. Historic Glimpses in the Old World, by Rev. Dr. Mathews.
Feb. 19. The Origin of the Saguenay, by Abbé J. C. K. Laflamme.
Feb. 26. Hudson Strait, by Mr. W. A. Ashe.
March 12. Stories of Coast Life, and Description of some of the least known and most interesting Fish of Canada, by Mr. J. U. Gregory.
March 19. Railways and Waterways, by Mr. Joseph Shehyn.

Our membership includes at the present time about two hundred and thirty names, and a Committee has been appointed to secure additional members, in order to place the Society in a sound financial position. During the year, twenty-four new members have been elected, while twelve of the old members have withdrawn. Six of our most highly esteemed members died during the year, viz., William Darling Campbell, Ninian Davidson, E. C. Burke, William Home, Michael Stevenson and Dr. Jackson. His Excellency the Marquis of Landsdowne, Governor-General of Canada, was elected

patron and honorary member of the Society; and the following gentlemen were elected corresponding members, viz., I. Allen Jack, Recorder of the City of St. John, N.B., and B. Percy Scott, of Windsor, N.S.

The Library continues to improve under the superintendence of the energetic Librarian, Mr. F. C. Wurtele, who reports that during the year 2,234 volumes were given out to members.

The following gentlemen were elected to office for the year 1885-6:—

President	George Stewart, Jun.
Vice-Presidents	Wm. Hossack. Cyr. Tessier. John M. Harper. J. Whitehead.
Treasurer	Edwin Pope.
Librarian	Fred. C. Wurtele.
Recording Secretary	J. F. Belleau.
Corresponding Secretary	W. S. Bennett.
Council Secretary	Alexander Robertson.
Curator of Museum	J. U. Gregory.
Curator of Apparatus	R. McLeod.
Additional Members of Council	J. M. LeMoine. Herbert M. Price. Hon. D. A. Ross. Peter Johnston.

Mr. R. Turner was appointed Auditor for the ensuing year.

III.—From the New Brunswick Natural History Society, through Prof. Bailey:—

The New Brunswick Natural History Society, of St. John, respectfully submits to the Royal Society of Canada the following report of progress for the past year:—

The Society has a membership of over one hundred members, and among them many active naturalists, who are doing zealous and careful work in the several departments in which they are engaged. Owing to the yearly grant received from the Local Government of New Brunswick, the Society has been enabled to increase its Museum accommodation, and to engage more effectively in original work. Valuable additions have been made during the year to its Museum, especially in the departments of geology, botany, zoology, ornithology, etc.

During the summer of 1885, a summer camp was held under the auspices of a working club of the Society, on Frye's Island, near the entrance to Passamaquoddy Bay. The work principally carried on was in geology, zoology and botany, and considerable introductory work was done in marine zoology and botany.

The accompanying Bulletin contains a more complete *resumé* of the work of the Society during the past year, and is herewith transmitted to the members of the Royal Society for their inspection.

IV.—From the Hamilton Association, through Mr. T. C. Keefer.

The Association has held nine meetings during the year just closing. The attendance at these meetings was good, and the interest manifested in the subjects brought before the members satisfactory. The following were the subjects of the papers:—

1. The Mound Builders' remains in Manitoba, by Mr. Charles N. Bell.
2. The Pressure and Elasticity of the Atmosphere (illustrated by numerous experiments), by Mr. A. Gaveller.

3. American Ornithology, by Mr. Thomas McIlwraith.
4. Pessimism, by Rev. Samuel Lyle.
5. The Phosphate Trade of Canada, by Dr. H. B. Small.
6. Telegraphic Communication with a Moving Train, by Mr. George Black.
7. Life in Nature and Evolution in Life, by Mr. J. Alston Moffatt.

Our Association is fortunate in having as a member Mr. Thomas McIlwraith, who has contributed during this Session so much original work to the Biology Section, in the shape of a full description of no less than two hundred and fifty birds of Canada. This important work has been handed over unconditionally to the Association, and will be published and distributed shortly, and will form a valuable addition to the science of ornithology.

The Geological Section has not been overlooked, for Lt.-Col. Grant and other members have added to our collection of specimens.

The Reading Room has been supplied with some of the leading scientific magazines and reviews.

Our present membership is one hundred and forty-five, twenty-four new members having been admitted during the Session.

V.—From the Murchison Scientific Society of Belleville, through Mr. T. Wills.

In presenting the report of the Murchison Scientific Society of Belleville, we have to express our regret that, in consequence of the pressing business engagements of so many of our members, not much original work has been done during the past year, but papers have been read on the following subjects: Fresh Water Sponges, the Early History of Electricity, Fruit and Flowers, and Physiological and Pathological Chemistry. Meetings have been regularly held, and several microscopical exhibitions have been given. The Society was honoured by a visit from the members of the Pharmaceutical Society of Ontario, which held its convention in Belleville, in August, and the conversazione which was given in their honour was well attended. Progress continues to be made with the Museum, and a number of valuable and interesting articles have lately been presented which add much to the attractiveness of the collection.

The officers for the present year are:—

President.....Mr. Thos. Wills.
Vice-President.....Mr. O. C. Greenleaf.
Secretary.....Mr. W. R. Smith.
Treasurer.....Mr. E. W. Edwards.

VI.—From the Institut Canadien-français d'Ottawa, through Mr. F. R. E. Campeau, C. St.-S.

Le bureau de direction de l'Institut Canadien-français d'Ottawa, fier comme les années précédentes de l'honneur que lui a fait la Société Royale du Canada en l'invitant à présenter un rapport sur ses opérations de l'année courante, peut se vanter de l'état comparativement prospère de ses finances.

Nous avons éprouvé, le 6 avril 1885, une perte considérable par l'effondrement du toit de notre édifice, mais les souscriptions généreuses de ses membres et d'autres personnes sympathiques, s'elèvant à près de sept cents dollars, ont couvert une partie de nos frais de reconstruction, qui se montent à plus de seize cents dollars.

Le gouvernement d'Ontario continue à accorder l'allocation annuelle de trois cents dollars, ce qui est d'un grand secours pour nous, surtout dans cette période critique que nous avons à traverser.

Le nombre de nos membres titulaires est de deux cent trente-sept.

Pendant l'année littéraire qui vient de s'écouler, onze conférences ont été données devant

l'Institut, en présence d'assistances généralement nombreuses, qui témoignaient de l'intérêt porté aux lettres par la population française d'Ottawa.

Ces conférences se résument comme suit : —

1o La langue que nous parlons, par M. Napoléon Legendre, de la Société Royale.
2o Deux femmes d'après Corneille, par le R. P. Fillâtre, O.M.I.
3o Montcalm, par M. P. J. Ubalde Baudry, greffier adjoint du conseil privé.
4o Une résurrection, par le R. P. Nolin, O.M.I.
5o Au pôle nord, par M. Achille Talbot, avocat.
6o L'étude des sciences naturelles, par le R. P. Marsan, O.M.I.
7o Les traces d'aborigènes constatées par la découverte de spécimens archéologiques, par M. Faucher de Saint-Maurice, M.S.R.C.
8o Nos premières relations littéraires avec la France, par M. Alphonse Lusignan, de la Société Royale.
9o L'Angleterre et la Russie dans l'Inde, par M. Napoléon Champagne, secretaire de l'Institut Canadien-français d'Ottawa.
10o Les falsifications dans le commerce et dans la société, par le Dr F. X. Valade.
11o Le drame et les auteurs dramatiques au Canada, par l'honorable Pascal Poirier, sénateur.

Je constate un intérêt pour nos séances publiques, qui ne s'abat point. Sans doute, le nombre de ceux qui viennent s'instruire à notre foyer n'augmente pas vite, mais c'est une consolation de savoir qu'il ne décroît pas.

Tout dernièrement, nous avons noué des relations avec cinquante-sept sociétés littéraires et scientifiques, dont :

26 de France, 14 des Etats-Unis d'Amérique, 4 d'Angleterre, 2 d'Italie, 2 de Suisse, et 1 de chacun des pays suivants : Algérie, Autriche, Bavière, Belgique, Ecosse, Egypte, Irlande, Russie, Sicile et Suède.

Les nombreuses publications que nous avons reçues de ces différentes sociétés sont autant de précieuses acquisitions pour notre bibliothèque, et, si la fortune nous favorise, nous pourrons peut-être un jour, peu éloigné je l'espère, publier nous aussi nos conférences et nos délibérations, que nous serions si heureux d'offrir aux sociétés avec lesquelles nous sommes en correspondance.

Somme toute, notre état financier et notre situation littéraire sont satisfaisants, et je puis ajouter qu'ils nous permettent d'espérer un progrès prochain.

En terminant, j'ai l'honneur de vous présenter la liste suivante des membres du bureau de notre institution pour l'année expirant le premier jeudi d'octobre mil huit cent quatrevingt-six : —

Président	F. R. E. Campeau, C. St-S.
1er vice-président	Chs Desjardins.
2nd " "	J. L. Olivier.
Secrétaire-archiviste	Napoléon Champagne.
Assistant secrétaire-archiviste	J. B. A. Pigeon.
Trésorier	L. J. Béland.
Bibliothécaire	Napoléon Boulet.
Curateur du musée	J. Auger.
Conseillers	Dr L. C. Prévost. Aug. Laperrière. J. A. Pinard. Ant. Champagne. P. H. Chabot. A. Blais.

VII.—From the Ottawa Field-Naturalists' Club, through Mr. R. B. Whyte:—

In presenting to your honourable Society the fourth report from the Ottawa Field-Naturalists' Club, the Council have great pleasure in being able to say that its work has been carried on with increased and gratifying success. The Club has, at present, over one hundred and eighty ordinary and seven corresponding members, making it numerically one of the strongest scientific societies in the Dominion, and as regards original work performed by the members, it can compare favourably with any similar society.

The usual excursions to places of interest in the vicinity were held at intervals during the summer, and many valuable facts concerning the natural history of this district were recorded.

Much useful work was also accomplished at the subexcursions, which were held on Saturday afternoons, to points in the immediate neighborhood of the city. These subexcursions are of the character of out-door classes, and are conducted with a view to enable the younger and less experienced members to study the different branches under the guidance of the appointed leaders, whose duty it is to give any assistance and explanation that may be necessary. During the winter, six soirees were held—one being an evening devoted to the microscope, at which short papers were read and slides exhibited, illustrative of the different subjects; while at the others the following papers were read:—

1. The President's Address, by W. H. Harrington.
2. The Black Bear, by W. P. Lett.
3. Water Crystallization affected by Magnetic or Electric action, by E. Odlum (Pembroke.)
4. The Teaching of Mineralogy, by Rev. C. F. Marsan.
5. Ottawa Dragonflies, by T. J. McLaughlin.

In addition, there were reports from the leaders of the work done during the year in the various departments of natural history, and notes by members. These, as well as the papers read, were followed by discussions of an interesting nature, which discussions are a distinctive feature of the soirees.

Afternoon lectures were also given during the winter on the following subjects:—

Entomology (4), by W. H. Harrington and J. Fletcher.

Mineralogy (1), by Rev. C. F. Marsan.

Ornithology (1), by W. L. Scott.

Botany (5), by J. M. Macoun and R. B. Whyte.

The five on Botany were delivered before the students of the Normal School, by request of Principal McCabe. In addition to these lectures, at the request of the Inspector of Public Schools for Ottawa, a weekly class in Botany has been organized as part of the regular instruction for the Senior Students at the Central School West. The attendance and attention displayed at this class have been most encouraging to the Senior Leader in Botany, who has undertaken the work.

The Council are much gratified to know that their efforts in the way of encouraging the study of natural history are being more appreciated, the attendance at the soirees, the excursions and the classes, has been larger, and the interest shewn by those present has been much more marked than in any previous year.

A copy of the Club Transactions, No. 6, containing 132 pages and 2 plates, is herewith submitted, and we hope that it will be found a creditable addition to our list of publications.

At the annual meeting of the Club, held on March 17, the following officers were elected for the year 1886-87:—

President	Prof. J. Macoun.
Vice-Presidents	R. B. Whyte. Principal Woods.
Secretary	W. H. Harrington.
Librarian	F. R. Latchford.
Committee	J. Fletcher, Dr. Small, Rev. Prof. Marsan.

The following leaders have been appointed in their several subjects:—

Geology—H. M. Ami, Prof. Marsan, H. P. Brunell and T. W. E. Souter.
Botany—R. B. Whyte, Principal Woods and Dr. H. B. Small.
Entomology—J. Fletcher, W. H. Harrington and T. J. McLaughlin.
Conchology—Hon. P. A. Poirier and F. R. Latchford.
Ornithology—W. L. Scott, G. R. White and J. M. Macoun.
Zoology—H. B. Small and W. P. Lett

SESSION II. (*Afternoon Sitting.*)

Reports from Affiliated Societies. (*Continued.*)

The members of the Society assembled at 3 o'clock, p.m., and the President called the meeting to order.

Mr. George Stewart, Jun., acted as Secretary in Mr. Bourinot's absence.

The Societies which had not reported at the morning meeting were then called upon, and the following reports were accordingly presented:—

VIII.—From the Entomological Society of Ontario, through Mr. W. H. Harrington:—

As delegate from the Entomological Society of Ontario, I have much pleasure in announcing that the Society which I have the honour to represent, continues its labours with undiminished energy and success. Its membership is large, and it is everywhere recognized as one of the most important scientific institutions of the country.

Its monthly publication, the *Entomologist*, continues to receive the support of, and to be welcomed by, entomologists of all places, and Vol. XVII. for 1885, is a most valuable addition to the recorded knowledge of American insects. The contributors to this volume, forty in number, include the leading Canadian workers, and many of the best known entomologists of the United States. A complete set of the *Entomologist* and of the annual reports will be found to contain a vast store of information in regard to the structure, classification, distribution, and habits of our insect foes and friends.

The title "Entomological Society of Ontario" might lead many to suppose that its work was limited to this province, but in reality, it is carried on by members in all parts of the Dominion, from Prince Edward Island to British Columbia. The faunas of the latter province, and that of the Northwest Territories have been investigated during recent years by several experienced collectors, and large additions have been made to Canadian lists, and many new species discovered in the several orders of insects.

Through the contributions of members, the collection maintained by the Society has rapidly increased in size and value. By special request of the Dominion Government, this collection has been sent to the Colonial Exhibition just opened in London. It was first carefully rearranged by members having special knowledge of the various orders, and was much improved by having a large proportion of the old specimens replaced by fresh material, and by having a large amount of new material incorporated. The collection, as thus arranged and enlarged, fills over one hundred large cases, and will undoubtedly favourably impress all beholders with the great number and variety of our insects.

The Society has learned with pleasure that a competent entomologist is proposed to be employed in connection with the experimental farm to be started for the investigation of scientific agriculture. Such an officer is a decided essential, and his duties will be, to quote from Prof. Saunders's Report to the Department of Agriculture, "to investigate the habits of insects destructive to farm and garden crops, fruits, etc., as well as those affecting animals, with a view of testing such remedies as may be available for their destruction. He should also prepare such collections for the Museum at the Cen-

tral Station as would illustrate the insects injurious and beneficial to vegetation, and duplicate collections of a similar character, as early as practicable for each of the substations."

In this connection, it may be stated that Mr. Fletcher, who is at present acting as Honorary Entomologist, has, under exceptionally unfavorable conditions, and without being able to devote his time to the work, or to employ needed assistance, published a report containing a large amount of information about the insects which were found to be most injurious during the past year. The report is based upon his personal observations in different sections, and upon voluminous correspondence from all parts of the Dominion. It is an earnest of what might be accomplished by an entomologist having the necessary equipment and assistance to prosecute and record investigations.

Fortunately, neither from Mr. Fletcher's report, nor from those of the Entomological Society, do we find that any especially destructive new pests were met with during the past year, nor were some of the old ones so abundant and devastating as formerly. The ravages of the Larch Saw-Fly (*Nematus Erichsonii*) and of the Spruce-bud Moth (*Tortrix fumiferana*) showed signs of decrease. The Clover-seed Midge (*Cecidomyia leguminicola*) continued to do serious injury over extended areas, but if farmers will act upon the suggestions which have been made in our reports regarding the cultivation of this crop, they can harvest a good yield of seed.

Two of the most destructive insects in Canada for many years past have been the Codling Moth (*Carpocapsa pomonella*) and the Plum Curculio (*Conotrachelus nenuphar*), the former destroying or injuring probably one-fifth of our apple crop, and the latter often causing a total failure of the crop of plums. Numerous remedies have been proposed and employed against these pests, but the labour required was, in each instance, considerable, and the results were scarcely ever entirely satisfactory. Experiments made during recent years by our members have, however, proved that Paris green is an efficient and practicable remedy, when mixed with water and sprayed upon the trees as soon as the flowers have been fully fertilized.

These facts are mentioned by me in order that a knowledge of them may be diffused by the Fellows of your honorable Society, and by the Delegates to this meeting.

The loss to the country annually by the ravages of insects upon crops of all kinds is so enormous, that it becomes the duty of every society, interested in the prosperity of the country, to do what may be in its power to enable agriculturists to conquer their small but numerous foes.

IX.—From the Société de Géographie de Québec, through Abbé Laflamme :—

Le comité de régie de la Société de Géographie de Québec a l'honneur de faire un rapport des opérations de la Société pendant l'année 1885.

Le bail de notre société avec l'Institut Canadien de Québec expirait le 30 avril 1885, et le prix du loyer devenant trop onéreux pour nos ressources, nos directeurs ont dû songer à trouver un autre local. Après bien des recherches infructueuses, nous avons décidé de faire un marché avec messieurs les commissaires du gouvernement fédéral chargés de l'octroi des licences dans la ville de Québec, par lequel nous avons eu l'autorisation d'occuper conjointement avec eux les salles dans lesquelles nous nous réunissons encore aujourd'hui. Cette installation n'était que temporaire, et entraînait de sérieux inconvénients ; mais nous avons dû nous en contenter jusqu'à ce jour. Nos successeurs seront sans doute plus heureux que nous dans leurs démarches pour régler cette importante question ; nous le souhaitons vivement.

Le lac Mistassini a continué d'attirer l'attention publique durant l'année qui vient de s'écouler. On se rappelle les démarches nombreuses et pressantes entreprises par notre Société depuis plusieurs années pour engager les gouvernements d'Ottawa et de Québec à faire explorer cette immense région encore à peu près inconnue.

Nous voulions connaître les ressources du grand nord de notre province, et nous avions l'ambition bien légitime d'assurer à la partie occidentale de la Confédération canadienne les mêmes chances

d'agrandissement et de progrès vers le Nord, que celles obtenues par nos concitoyens d'Ontario, du Manitoba et la Colombie-Anglaise. Le résultat de nos efforts a été l'organisation d'une expédition au lac Mistassini sous l'autorité combinée des gouvernements d'Ottawa et de Québec, et préparée par la commission géologique du Canada et le département des Terres de la couronne de Québec. Bien que nous ne puissions pas maintenant juger la valeur des résultats pratiques de cette exploration, parce que les rapports officiels n'en sont pas encore publiés, il nous est cependant permis d'espérer que nous en recueillerons des fruits précieux pour la science géographique et pour la connaissance de notre propre pays.

Malgré la modicité de nos ressources, nous avons pu continuer la publication de notre bulletin, et le No IV est maintenant prêt à être distribué. On y remarquera que les études sur la région du lac Mistassini et les vallées du lac Saint-Jean et du Saguenay, et la question des explorations en général ont été la préoccupation dominante de nos conférenciers et de nos collaborateurs.

Notre société a continué d'être en rapports d'amitié avec la plupart des sociétés de Géographie du monde entier, et la longue liste de nos échanges et des dons que nous avons reçus prouve que notre Société est tenue en grande estime chez nous et à l'étranger.

Nous saisissons avec empressement l'occasion de notre assemblée générale pour offrir nos sentiments de vive reconnaissance aux hommes distingués qui ont contribué par leurs écrits et leur conférences à la confection de notre bulletin, et aussi aux nombreuses sociétés et aux bienfaiteurs dont les envois généreux ont enrichi notre bibliothèque.

L'année 1885 a moissonné parmi nos membres et nos officiers. Elle nous a enlevé un homme distingué dans la personne de M. Franklin B. Hough, de Washington, membre honoraire, et un jeune officier de notre Société, M. Joseph Chouinard, l'un des assistants secrétaires-correspondants.

Le rapport de notre trésorier démontre avec l'éloquence irrésistible des chiffres la nécessité des efforts sérieux pour ranimer le zèle de nos membres, pour rallier ceux qui nous ont laissés, pour recruter en grand nombre de nouveaux adhérents, afin que l'œuvre entreprise par notre Société, non-seulement ne périsse pas, mais grandisse et produise la riche moisson ambitionnée par nos fondateurs. On ne saurait trop déplorer le malheur des temps qui a forcé, nous aimons à le croire, le gouvernement de Québec à supprimer les octrois aux sociétés qui s'occupent de science et de littérature. Espérons que le moment n'est pas éloigné où les efforts généreux des rares adeptes de la science et des lettres en notre pays ne seront pas entièrement méconnus, qu'après avoir largement pourvu aux besoins matériels de notre peuple, on fera une part aussi large que possible des deniers publics pour aider à ces associations qui travaillent, avec désintéressement et sans espoir de récompense pour leurs membres dévoués, à favoriser une belle et noble cause, la cause de la science et de l'éducation, et font à elles seules, au Canada, ce qui dans tous les pays est l'œuvre des gouvernements, c'est-à-dire une œuvre nationale.

Addresses of the President and Vice-President.

The President, Dr. Daniel Wilson, then delivered the following address:—

We meet to-day after another year of work as a Society, to report progress, and to submit, in the various Sections, the contributions of the year to the departments of letters and science embraced within our comprehensive organization. In fulfilling the duty that now devolves on me, I might be tempted to follow the example of some who, in analogous positions, have surveyed the whole field of work, with its possibilities and opportunities: I might aim at a *resumé* not only of the actual achievements of Canadian science and letters, but of all that lies within the compass of its most ambitious aims. But such an attempt would involve a review of the intellectual life of the age. Physics and metaphysics, palæontology, archæology, history, and *belles-lettres*, all alike claim our attention; but amid the wide diversity of intellectual activity which marks the era, a disposition is increasingly

manifested to give the foremost place to questions which directly affect humanity. The speculations of science more and more converge towards one centre; and along with this it is impossible to overlook the growing tendency among one class of inquirers to translate hypothesis into scientific dogma. It is well that we should ever bear in remembrance that "Evolution," which is the magic word assumed for the present to solve all difficulties, necessarily implies progressive change; and so points to a beginning—a Creator. This novel hypothesis of the great English naturalist of our century, which offers for its acceptance a new science of life, has revolutionized the whole course of scientific speculation. The geologist, responding to its appeal, undertakes, on strictly scientific evidence, the significant problem of the antiquity of man. The biologist unites with the palæontologist, in a renewed search for his pedigree. The psychologist has embraced within the sphere of his philosophic speculations the evolution of the intellectual powers, the conscience, and the will; and assumes no less dogmatically to determine the descent of mind.

With so vast a range of speculation thus comprehended within the field of scientific research, the most gifted student might well hesitate to cope with the theme, in this its revolutionary stage. For me, the attempt would be altogether presumptuous; and I shall best fulfil the duty now devolving on me by limiting myself mainly to one department of research, which, as I conceive, has special and urgent claims on the attention of this Society at the present time.

The Science of Language, itself among the youngest of the sciences, has not escaped the influence of the new revolution; and novel theories of the evolution of language itself supersede earlier inquiries into the origin of letters. In one respect the Royal Society of Canada differs in its constitution from older kindred societies of the mother country, in so far as it includes, within the recognized work of its Sections, both French and English literature. Here, accordingly, language finds its legitimate place; and without embarking on the seemingly shoreless sea of speculation and hypothesis that I have indicated, there are certain aspects of comparative philology which are full of interest and value to ourselves as Canadians. This department of study will not hamper in any degree the legitimate operations of other Sections; though it may influence inquiry in certain allied directions. But here, it seems to me that, without limiting the freedom of individual members in their choice of subject, much work of great practical value may be accomplished by a judicious selection of themes specially necessitating prompt consideration. The literature of France, with its "Chanson de Roland," its Froissart, its Molière, Corneille, Racine; and all its brilliant creations, to the latest productions of de Musset or Merimée, pertains, like contemporary English literature, to European classics. Canadians may emulate the great masters in letters, as they have already done in more than one department; but the republic of letters is free to all without the fostering aid of a Society such as this. It is, indeed, a matter of just interest to watch the growth of a native Canadian literature in the languages both of France and England; and to trace the influence of novel environments moulding and fashioning our intellectual, no less than our physical development. But without slighting this attractive branch of work, it appears to me that more important results may be anticipated from a class of communications that have already received some attention in the past, and which I hope to see making greater demands on our space in the future. They are exemplified in the volume of Transactions now issued, in such papers for example, as "La race française en Amérique," "L'élément étranger aux Etats-Unis;" etc., as in previous volumes, we had "Les races indigènes de l'Amérique devant l'Histoire," "Les aborigènes d'Amérique, leurs rites mortuaires;" and in another, but not less interesting aspect: "La province de Québec et la langue française." In like manner, in both the present and the past volumes, papers on "The Half-Breed," "The Huron-Iroquois," and others of the aboriginal races of the continent have been contributed to Section II. Thus the ethnology and comparative philology, not of Canada only, but of America, have, to some partial extent at least, been brought under review. It is a small portion of the wide field mapped out for our joint labours; but in this direction, as it seems to me, valuable results may be anticipated, marked by such local character as will naturally be looked for from our Canadian Royal Society, and constitute a

special feature of its Transactions. The polished language of cultured France, though here transferred to a region beyond the Atlantic, is kept *en rapport* with the Parisian centre of refinement, and fed from the perennial fount of French literature. But here also are the peasants of Normandy and Brittany, transplanted to "la Nouvelle France," under the old regime, bringing with them to their new home a provincial patois, embodying elements peculiar to those scenes of Scandinavian colonization and Celtic institutions. Here, unaffected by revolutions that have so largely influenced the more recent history of France and of Europe, they have dwelt for generations, intermingling to some extent with the aborigines, and brought into novel relations with other intrusive races of the New World. To the modern Frenchman, they cannot fail to present in many ways a singularly attractive study; but it is in their philological aspect that the widest value lies; and the changes already noticeable in idiom and vocabulary, have awakened an intelligent interest among many students of language. The cultivated Frenchman not only brought with him to his new home, a written language, and a literature rich and varied in its attractions, but the intervening ocean has scarcely impeded his enjoyment of its latest triumphs. But the *habitant* has stood in very different relations to the language. It was to him from the first an unwritten local dialect; and now illustrates, in some singularly striking aspects, the beginning anew of a process of evolution akin to that to which we owe the whole Romance languages. This is a branch of comparative philology, of interest to all Canadians, and which has a special claim on the attention of Section I.

But a wider interest pertains to the native languages, and to the indigenous races of this continent. Their approximation in physical characteristics to the Asiatic Mongol renders all the more remarkable the wide diversity of speech between the two continents. On both, indeed, an agglutinate character predominates in large groups of languages; but beyond this, any affinities thus far traced out are remote and uncertain. Here, therefore, is a problem in comparative philology, of which a solution may not unreasonably be looked for from us. In this direction unquestionably lies the determination of questions relating to the origin of the American race; the ethnographic key to the earliest migrations; the prehistoric chronicle of this western hemisphere; the interpretation, it may be, of the venerable myth of the lost Atlantis, which vainly excited the interest of the disciples of Socrates, as even then a tradition from old times before that era to which they belonged, when the world was two thousand three hundred years younger than it is now.

Looking to the subject in its narrowest aspect, the native languages of this continent are deserving of careful study; and those of our own Dominion have a claim on our attention, as a Society, which we cannot ignore without discredit to ourselves. We owe not a little of the knowledge of them, thus far secured, as one—and not the least valuable—of the results due to the devoted labours of French missionaries for upwards of two centuries among the Indians of Canada and the Northwest. The Huron version of the Lord's Prayer, reproduced in the second volume of the Society's Transactions, was derived from a MS. of the seventeenth century, ascribed to the Rev. Father Chaumonot; and is of value as an example of the language of that race, when first brought into intimate intercourse with Europeans. The vocabulary of the language, prepared by the same zealous Jesuit missionary, is still in existence; but its present custodian, M. Paul Picard, son of the late Huron Chief, Tahourenche, has hitherto repelled all applications for its purchase, and even for permission to have it printed. Its genuineness is placed beyond dispute by the date of the water-mark on the paper, and its interest and value are unquestionable. Our earliest knowledge of the native vocabulary of the Province of Quebec is derived from the two brief lists furnished by Cartier as the result of his visit in 1535; and a comparison of them with the Huron vocabulary leaves no doubt of their affinity. We have also the dictionary of the Recollet Father, Gabriel Sagard, printed at Paris in 1632. But the recovery of the vocabulary of Father Chaumonot, and its printing by the Royal Society, will furnish an important addition for the study of the language of a people interestingly associated with the early history of Canada, and will be a creditable work for either of the Literary Sections. I regret that my own efforts to obtain access to the MS., with a view to laying it before the Section of English Literature and of History, have thus far failed.

We already owe to the "Lexique de langue iroquoise," and to the "Etude philologique sur quelques langues sauvage de l'Amérique," of Abbé Cuoq, valuable help to the study of the Iroquois and Algonquin tongues. We are no less indebted to the Rev. Father Lacombe for the like aid in his "Dictionnaire et grammaire de la langue des Cris." But the frontiers of Quebec are still occupied by native tribes little affected by the civilization of European intruders, and beyond this, the Eskimo of Labrador are easily accessible. In Ontario, the Huron-Iroquois are being transformed into an industrious, civilized people. In the Maritime Provinces, the Micmacs and Milicents are in process of like transformation; and on many Canadian reserves, the representatives of Algonquin and other tribes are now settled, and gradually learning to conform to the usages of their supplanters. But in such a process, language and much else which is invaluable to the ethnologist, must disappear; and still more is this the case in the great wilderness of the Northwest. There, in very recent years, the buffalo roamed in vast herds, furnishing an unfailing supply, not only of food, but of furs and skins, from which the tents, robes, and couches of Crees and Blackfeet were fashioned, and on which the Hudson Bay factors largely depended for like supplies. The Indian tribes lived around the Hudson Bay forts much after the fashion of their fathers, bartering the produce of the chase for other needful supplies. But now all this is at an end. A revolution of the most radical character has supervened. The inevitable disappearance of the wild hunter tribes of the Northwest, at no distant date, can no longer be questioned. Some memorial of the native races will, doubtless, survive in civilized tribes settling down to cultivate the soil over which their fathers roamed as nomad hunters. But such a process cannot fail to involve the extinction of the native languages from which alone the ethnical affinities and the history of the race are to be recovered.

Nor must we overlook the significance of the fact that the Province of Manitoba began its independent career with a population of some ten thousand half-breeds. In that old historic past, when the gifted Roman annalist followed on the steps of imperial conquest in the British Islands, the dark type of the Silurian Britons was noted by Tacitus, and assigned by him to an Iberian source. In the latest classification of anthropologists, the modern representatives of this persistent type are designated "Melanochroi," the assumed representatives of the *metis* of Europe's prehistoric dawn, when the first wave of Aryan immigration came in contact with their Turanian or Allophylian precursors. Here, in our own Dominion, the same great Aryan wave, which reached the shores of the New World before the close of the fifteenth century, and, with ever added volume, has driven before it the native tribes, moves westward with irresistible aggression; and on our Northwest frontier, the same results are everywhere apparent. The ethnological history of Europe repeats itself here; and this phenomenon of the rise of a race of mixed blood settling down among the intruding colonists is replete with interest to the student of ethnology.

I bring this subject under your special notice now, because it is one that demands immediate attention, one indeed that will not brook delay. The Indian may survive for a time. The interblended elements due to the contact of native and intruded races, I doubt not, will remain as a permanent factor in our future population. But the aboriginal arts must vanish; the native traditions, in which so much history lies embodied, will scarcely survive to another generation; and as for their languages, if not recovered from the lips of the living generation, they will ere long be as utterly beyond recall as the snows of the past winter. Yet it is to comparative philology that we have to look for the solution of problems of highest interest and value to ourselves. If we are ever to recover any reliable clue to the ancient history of this continent, and the source and affiinities of the nations to whose inheritance we have succeeded, this can only be done by means of comparative philology; and for this, the materials must be gathered ere it be too late. "The Comparative Vocabularies of the Indian tribes of British Columbia," the work of one of our own members, in conjunction with Dr. Fraser Tolmie, which was published in connection with the Geological and Natural History Survey of Canada, in 1864, is a timely and valuable contribution to the desired

materials. But the reception which it met with from those in authority was not greatly calculated to encourage the repetition of such disinterested labours.

It is in work of this kind, at once of great practical value, and yet essentially unremunerative, if judged by the test of mere profitable pecuniary results, that Canada has to look for the most beneficial labours of its Royal Society. The history of the Geological Survey, both here and in the United States, is well calculated to guide us in this respect. Geology has long enjoyed the fostering care of the Government in both countries, though rather in its economic, than in its scientific aspect. Large sums have been expended, and an efficient staff employed, in surveying and mapping out the geological structure of the continent. The sister sciences, and especially those of mineralogy and chemistry, have been enlisted in its service; and palæontology has necessarily been largely elucidated in the combined research. But the urgent demand is ever for what are called practical results. True, it is to the disinterested study of pure science, to the love of abstract truth, that we owe all the grand, practical fruits by which science is revolutionizing the world. But Canada has been, till recently, sufficiently indifferent to this; and as for the United States—after doing splendid work in geology, ethnology, hydrography, geodesy, and meteorology, and publishing works of no less scientific than practical value—a commission recently appointed by Congress to investigate the operations of the various scientific bureaus, has draughted a bill restricting the work and publications of the Geological Survey, and absolutely forbidding the expenditure of any portion of the Government appropriation for the publication of palæontological material, or for the discussion of geological theories. In other words, there shall be no seed-time for science. Henceforth it must be harvest through all the seasons. This, I doubt not, is a mere passing phase of misapplied thrift, which will speedily give place to a wiser recognition of the economic value of all scientific research. But I refer to such experience elsewhere, rather than to any action in our own Dominion, because we may the more impartially estimate the probable results. The scientific value of the labours, and of the published results, of the United States Geological Survey has been widely recognized; and the restrictions suggested by the recent commission, will be felt throughout the scientific world, even more keenly than would the withdrawal of American specie and all its equivalents by the commercial world. It will not only be a great discouragement to American science, but, if persisted in, would enormously diminish the practical usefulness of the Survey. It is impossible to neglect pure science, and yet hope to reach those results which are but its latest fruitage. Palæontology, with all its marvellous disclosures relative to ancient life; chemistry, with its determination of the origin of crystalline rocks, or its wondrous spectrum analysis, revealing to us the physical structure of the heavens; or physics, with its more comprehensive discoveries of the correlation of forces—all alike present themselves to the "practical" mind as mere sports of scientific speculation, with no possible bearing on the economic needs, or the industrial interests of the community. What can it benefit the miner to learn of Tertiary vertebrates; or the farmer to be assured of the verification of the Hesperornis, the Ichthyornis, or other toothed birds of the Cretaceous strata of our North American continent? It is not indeed a matter of wonder that, to the man of "advanced vews" in political and social science, who claims above all things to be "practical," it should seem a matter of equal indifference whether the dawn of life has been discovered in the *Eozoon Canadense* of our Laurentian rocks; or the existence of palæolithic man in America has been demonstrated by the recovery of the turtle-back celts in the drift of New Jersey. Nevertheless, to note only one familiar instance, the determination of the relative age of the strata of the Earth's crust has been of scarcely less economic value in the Provinces of Quebec and Ontario, in saving the useless expenditure of many thousands of dollars in a vain search for coal, than in guiding the geologists of Nova Scotia in the development of their rich coal fields. It is the same in every department of science. Amber (ἤλεκτρον) furnished the first hint of latent Electricity, which perpetuates in its name the seemingly insignificant beginnings of that branch of science to which we now owe the telegraph, the telephone, electric light, the ocean cable; which have annihilated space, and outstripped time in their winged messages

over land and sea. Yet such is the world's inheritance, won for her in the ardent search for abstract truth, in the unselfish devotion to pure science. We can no more look for the practical fruits of science without such preliminary labour, than for the reaping of the harvest where there has been no seed-time.

The institution of this Royal Society by the Canadian Legislature is in itself a recognition of the value thus assigned to pure science. By our constitution it is provided "that the advice and assistance of the Society shall at all times be at the disposal of the Government;" and in no way can this be more legitimately rendered than by interposing to prevent a premature demand for economic results arresting the researches of science. We are not likely to forget that Canada is still a young country—favoured in many ways on that very account, by reason of the unimpeded course that thus lies before us; but also with some of the difficulties incident to national youth. The learned societies of Europe have, in many cases, endowments at their disposal, which enable them to render efficient aid to science, and to issue costly works dealing with subjects such as no publisher would view with favour. No such endowments as yet exist in Canada; and occasions will occur when it may be our duty—looking to the true interests of the Dominion—to recommend to the Legislature a liberal encouragement of the higher work of pure science in various departments, without neglecting those immediate practical results which the country reasonably looks for as evidence of the enlistment of science in the service of the people.

The volume of Transactions now issuing from the press will, I believe, be found in some respects in advance of its predecessors, and do no discredit to the representatives of Canadian letters and science. I have already referred to some of the contributions embodied in the work of Sections I and II, when inviting to a line of research, in which the biologist, no less than the philologist and the *littérateur*, will find a legitimate field. The contributions to Section III will also be found to include valuable work, alike in pure physics and mathematics, and in their practical application. The Council of the Society had occasion during the past year to press on the Government the desirableness, in the interest of our commercial navy, of carrying out a systematic hydrographic survey, not only in the Gulf of the St. Lawrence, but along our whole Atlantic and Pacific coasts, so as to follow up the work already so efficiently executed by the United States Geodetic and Coast Survey. In connection with this, attention may be fitly directed now to a valuable paper on "Tidal Observations in Canadian Waters." I may also be permitted, without invidious distinction, to note in Section IV the continuance, by Mr. Matthew of St. John, of his description of the Cambrian fossils, adding considerably to our knowledge, and keeping Canada in advance of other parts of the Continent on this subject. A contribution by Prof. Ramsey Wright on the anatomy of an interesting group of fishes, will, I believe, be found to introduce a style of work of which little has hitherto been done in Canada. The catalogue of Canadian butterflies, by Mr. Saunders, renders our knowledge more complete and systematic; and gives information as to their local distribution, which may be of practical significance in relation to a branch of animal life, which, however beautiful, is regarded with well-grounded disfavour by the agriculturist. Sir William Dawson's paper on the latest Cretaceous discoveries of fossil plants in the Northwest, adds to North American geology a new horizon of Lower Cretaceous plants not previously known, including a number of novel and interesting species. I may also refer here to the contribution by Professor Chapman of a piece of local economic geology in his account of the Wallbridge hematite mine, in order to note in passing that this was, I believe, one of the deposits resorted to by the aborigenes, and used as a pigment. Among the primitive native implements in the Redpath Museum, at Montreal, may be seen the antler picks and shells used by the Indians in collecting the hematite for their own purposes.

In this slight and very partial glance at some among the subjects treated of in the new volume, my notice is necessarily meagre, as I have only had access to some of its detached sheets; and therefore cannot pretend to aim at any exhaustive review of the work embraced in its varied contents. By our very constitution, as a Society, alike scientific and literary, the range of themes is

necessarily comprehensive and diversified. In all alike, we shall ever, I trust, set before ourselves, a lofty standard; finding in literature a stimulus to the highest culture, and in science the motive to a reverent, yet fearless search for all truth.

The Vice-President, the Very Reverend T. E. Hamel, then spoke as follows:—

Monsieur le Président, Messieurs:—L'objet de la Société Royale est d'encourager l'étude et le développement de toutes les branches du savoir au Canada. Deux choses sont donc en présence comme buts de nos efforts combinés: le développement des ressources matérielles et intellectuelles que peut présenter notre immense pays, pour le plus grand avantage de ceux qui l'habitent, et l'élévation du niveau intellectuel de notre jeunesse studieuse. Inutile de dire que la première partie sera comme un écho de la seconde, et que nos ressources tant matérielles qu'intellectuelles se développeront d'autant plus vite que le pays présentera une armée plus nombreuse de travailleurs zélés et intéressés. C'est à augmenter cette armée que travaille la Société Royale du Canada.

Mais y a-t-il de l'ouvrage pour tant de travailleurs? — La réponse à cette question est probablement ce qui a embarrassé un certain nombre de personnes, lorsque Son Excellence le marquis de Lorne a jeté les premiers fondements de la Société Royale. On a alors contesté l'utilité pratique de cette société, et on lui a prédit une existence éphémère, voire même la plus triste fin, l'inanition. Seulement, tandis que les uns trouvaient le pays trop bien organisé, d'autres au contraire le trouvaient trop peu avancé pour une semblable société.

Les premiers soutenaient que la Société Royale n'avait pas sa raison d'être dans le pays, parce qu'il n'y a rien à faire comme encouragement à l'initiative privée; que, d'un côté, les lettres prennent un développement plutôt à modérer qu'à exciter, et que, de l'autre, pour les sciences, la commission Géologique du gouvernement et les sociétés d'Histoire naturelle du pays absorbent tout ce qui peut être un objet d'étude.

Il semble quelque peu paradoxal de dire que notre pays est tellement bien organisé qu'il n'y a plus qu'à se croiser les bras et à laisser faire. Cependant, sans partager précisément cette idée, un bon nombre de nos compatriotes paraissent être sous l'influence d'un préjugé qui conduit pratiquement au même résultat. On dirait que nous avons pris à la France l'idée que tout ce qui sort de l'intérêt particulier et de ce qui ne regarde que le besoin spécial de la famille individuelle, doive être fait par le gouvernement. C'est là une manière de voir qui nous distingue complètement de nos compatriotes d'origine anglaise, et malheureusement à notre désavantage.

Tandis que l'Anglais cherche constamment à se rendre utile à la société par les efforts de son initiative privée, le Canadien-français se fait un scrupule de travailler pour l'avantage général, à moins d'y être obligé par une fonction gouvernementale. Ce n'est pas que l'on ait horreur de procurer le bien public, car c'est une course au clocher parmi nos jeunes gens pour avoir *une place* du gouvernement. Or je dis que c'est là une tendance dangereuse, parce qu'elle favorise cette nonchalance intellectuelle qui ne voit rien à faire pour le public, en dehors de ce qui peut rapporter immédiatement quelques sous à la famille. Au surplus, cette malheureuse tendance conduit, comme autre conséquence, à l'étroitesse d'esprit et à la mesquinerie. Heureusement c'est un défaut guérissable, et c'est à cette guérison que contribuera la Société Royale, en encourageant le travail individuel et l'initiative privée.

Hâtons-nous de faire voir que l'ouvrage ne manquera pas; et cela, au risque de paraître, pour quelques instants, favoriser l'opinion de ceux qui prétendaient que la Société Royale était une œuvre prématurée, parce que le pays ne présente pas encore assez de ressources pour fournir les éléments d'une société organisée sur des bases aussi larges. Ces personnes soutenaient que les associations de ce genre ne peuvent convenir qu'aux vieux pays, dans lesquels les ressources accumulées pendant des siècles permettent à une classe assez nombreuse d'hommes indépendants de fortune, de se livrer à des

travaux et à des recherches de longue haleine, sans crainte de la faim, et sans être obligés de gagner leur pain de chaque jour.

Eh bien, oui, cela est vrai, Messieurs, notre immense pays n'est encore que dans l'enfance, et tout y est à faire. Ne nous laissons pas éblouir par nos magnifiques voies de communication. Il y a longtemps que nous jouissons de nos fleuves, ainsi que de nos lacs, qui sont des mers; mais ce n'est pas ce qui a fait avancer l'étude de nos ressources naturelles. De même, si nous avons ou si nous espérons avoir bientôt un magnifique réseau de chemins de fer; si nous pouvons admirer ce colossal *Pacifique Canadien*, qui nous met à quelques jours seulement des Montagnes Rocheuses et de Vancouver; — c'est le commerce qui l'a fait pour son besoin, comme il l'aurait fait ailleurs, s'il l'eût trouvé plus avantageux. Mais encore une fois ce n'est pas cela qui fait connaître les ressources du pays, excepté en ce sens qu'il en facilite les recherches. En réalité tout reste encore à étudier.

Remercions le gouvernement de ce qu'il a fait jusqu'ici, surtout par l'institution de la commission Géologique, et prions-le de faire encore beaucoup plus. Mais ce ne sera pas assez. La commission Géologique n'a, jusqu'à ce jour, fait examiner qu'une bien petite partie de nos interminables domaines, et ce qu'elle a parcouru garde encore bien des détails secrets à scruter. Ses ressources, très limitées, ne lui permettent guère de constater, pour bien dire, que les grandes lignes. Or, s'il en est ainsi de la géologie, que faut-il penser des autres parties, moins favorisées, des sciences naturelles?

Pour me servir de l'expression de notre premier président, sir William Dawson, s'il y a quelque part des fruits à recueillir, ce ne peuvent être encore que des fruits de printemps. Et partout ailleurs, loin de songer à la récolte, nous n'en sommes qu'à l'époque où il faut défricher, éclaircir, labourer, planter et semer.

Jetons un coup d'œil sur le champ ouvert à nos efforts. Laissons de côté la physique, la chimie et l'astronomie, qui supposent plus de ressources et ne sont pas toujours accessibles aux études privées, bien que nos collèges et nos grandes écoles puissent faire beaucoup dans ce champ d'observation. Mais il y a la météorologie, la minéralogie, la géologie locales, qui peuvent toujours ajouter à la science générale, et qui sont accessibles à l'étude privée.

Puis vient l'étude des êtres vivants, animaux et végétaux. A part les grands animaux qui sont recherchés par le commerce, et nos grandes essences forestières, la faune et la flore de notre pays ne sont qu'incomplètement connues par les travaux de quelques chercheurs infatigables, qui sont bien loin de suffire à la peine. Quant à la paléontologie, qui suppose l'anatomie et la physiologie comparées, elle n'est étudiée que par quelques rares sommités de la science.

Chose singulière, il y a plus de cent ans que nos immenses forêts sont parcourues en tous sens par les chasseurs, les explorateurs de coupes forestières, les sauvages et les coureurs de bois de toutes les dénominations; il n'y a pas un lac, pas une rivière qu'ils ne connaissent et qui n'ait un nom, pas un versant de montagne, pas une vallée dont ils ne puissent vous dire les essences, et cependant, à part les endroits habités, la géographie de notre pays n'est pas connue d'une manière précise. Je doute fort qu'on puisse tracer sur une carte le cours exact de l'Ottawa jusqu'à sa source; et que dire des autres rivières bien moins importantes! Pourquoi? Parce que voyageurs, chasseurs et exploiteurs de forêts se contentent de jouir pour leur propre compte sans s'inquiéter du public. Si seulement quelques-uns de nos hommes instruits qui, de temps en temps, s'enfoncent dans nos forêts pour y faire la pêche ou la chasse, voulaient simplement se donner la peine de fixer leur itinéraire, d'y condenser leurs souvenirs et leurs informations certaines, ils rendraient de grands services à notre géographie.

J'ai parlé des sciences, parce que ce sujet m'est plus familier; mais nos amis des sections littéraires ne me pardonneraient pas si je ne signalais aussi les nombreux desiderata du champ de leur travail. Les ouvrages d'imagination, poésie et prose, ont certainement leur mérite, et doivent être encouragés; mais ce n'est là que le partie agréable des travaux littéraires. Il y en a d'autres beaucoup plus ardus, parce qu'ils supposent des efforts, des recherches, des études préliminaires pénibles.

Notre histoire, par exemple, surtout si l'on y comprend tout le Dominion, n'est-elle pas une mine

riche et féconde pour le chercheur consciencieux, même si l'on se borne aux faits et gestes des Européens et de leurs descendants en Amérique? Or il y a toutes les populations sauvages, si intéressantes à tous les points de vue, — populations qui tendent rapidement à disparaître, et dont l'histoire préhistorique présente tant de problèmes.

Les langues sauvages sont elles-mêmes des plus importantes à étudier, puisque bientôt elles n'existeront plus que dans nos livres. Et c'est avec beaucoup de raison que monsieur le président vient d'appeler sur ce point l'attention de la Société Royale.

Dans une autre direction se présentent à nous tous les problèmes de notre état actuel de société : l'économie sociale et politique, science qui suppose tant de statistiques encore inconnues; puis la lutte du travail et du capital, le paupérisme, la colonisation, l'éducation, la concurrence, la protection et le libre échange, les impôts directs et indirects. . . . Tout le monde parle de ces grands sujets qui intéressent à un si haut degré notre jeune pays; mais on en parle contradictoirement, parce qu'on ne les connaît qu'à des points de vue restreints, faute de ces recherches préliminaires, de ces chiffres, accumulés patiemment et sans parti pris, pour servir de base à une argumentation exempte de préjugés.

Comme on le voit, ce ne sont pas les problèmes qui manquent à nos recherches. Le danger est bien plutôt dans la crainte du découragement à la vue de tant de travaux, dans tant de directions différentes. Comment en effet aborder toutes ces études pratiquement? C'est ce à quoi je veux essayer de répondre, et ce sera le côté pratique de ces quelques remarques.

Avant de lire et d'écrire, on apprend patiemment à connaître et à former ses lettres. De même, avant de faire de la science d'ensemble, il faut commencer par en étudier, reconnaître et réunir les matériaux. Or c'est précisément cette étude préliminaire qui est essentiellement du ressort du travail privé. Il n'est pas même nécessaire d'indiquer dans quelle direction chacun doit exercer son énergie, puisque *tout* est à étudier. Que chacun se persuade seulement qu'il *peut* et qu'il *doit* se rendre utile en prenant une part quelconque dans l'accomplissement de cet immense programme; puis, qu'il suive son goût et *qu'il persévère.*

Vu l'importance du sujet, qu'on me permette d'entrer dans plus de détails, en prenant pour exemple l'Histoire naturelle, et, dans celle-ci, un des nombreux objets d'étude qu'elle présente, l'entomologie ou l'étude des insectes. L'entomologie comprend sept à huit grandes divisions : eh bien, je ne conseillerais pas à un amateur d'entreprendre la collection de toute la faune entomologique de son voisinage, ni même toute une des grandes divisions de cette intéressante étude, mais simplement un de ses grands genres. C'est le seul moyen d'arriver à s'en rendre maître, et de l'étudier à fond.

Vouloir faire autrement, c'est se morfondre et n'aboutir à rien d'utile, à moins de pouvoir y consacrer tout son temps, ou d'être doué d'une de ces volontés de fer, qui ne reculent devant aucune peine, et que les années ne diminuent pas, comme, par exemple, notre abbé Provencher. Mais les Provenchers sont rares, et il faut compter avec les faiblesses générales de la nature.

D'ailleurs ils sont peu nombreux ceux qui, parmi nous, peuvent consacrer tout leur temps à une étude quelconque, vu que chacun doit commencer par s'assurer le pain de chaque jour à l'aide d'une profession rémunérative quelconque. Aussi fais-je appel, en ce moment, non pas à des travailleurs qui se fassent une occupation unique de l'étude des sciences, mais à des personnes engagées dans une profession lucrative, et je leur demande seulement de consacrer une partie de leurs loisirs à une étude déterminée et restreinte. Cette étude, en même temps qu'elle sera pour elles une récréation, aura l'avantage de contribuer au progrès général.

Nous en avons un très frappant exemple dans notre illustre collègue, M. l'abbé Tanguay. Tenu à un ouvrage de travail déjà fatiguant par lui-même, M. l'abbé Tanguay a dévoué ses loisirs à un seul objet, classifier nos registres de baptêmes, mariages et décès. Ce travail si simple, commencé dans un petit nombre de localités, puis continué patiemment de paroisse en paroisse, durant plus de trente ans, a donné naissance à cet ouvrage monumental, unique en son genre, gloire de la race française en ce pays, le *Dictionnaire généalogique* des familles canadiennes. Et combien d'autres perles précieuses

dont ces registres, si arides en apparence, sont devenus la mine féconde entre les mains de notre infatigable travailleur!

On ne saurait donc trop faire valoir l'importance de concentrer les efforts de ses moments de loisir sur un objet restreint d'étude. J'ai connu un jeune naturaliste à Québec, ayant, dans le cœur de la ville, un jardin à sa disposition, et qui a entrepris, une année, dans ses moments libres, le matin avant ses heures de bureau, de faire la collection complète des insectes de tous genres qui fréquenteraient son jardin. La collection s'augmenta tellement qu'il dût renoncer à tout prendre, et se borner à certaines classes. On cite un autre amateur qui entreprit la même recherche sur une échelle bien plus réduite, en faisant avec soin la chasse aux insectes qui fréquentaient les quelques pots de fleurs, ornement de son balcon.

Si, dans chaque localité de notre immense Dominion, les quelques jeunes gens instruits qui s'y rencontrent, occupaient ainsi quelques-uns de leurs loisirs à la collection des spécimens ou à l'étude de l'une des mille subdivisions des trois règnes de la nature, *dans les environs de leur demeure*, chacun suivant son goût, et cela avec persévérance, quelle masse de matériaux ne ramasseraient-ils pas ainsi!

Or la science est communicative de sa nature. Ils sont bien rares, et heureusement, ceux qui se plaisent à étudier égoïstement pour eux-mêmes. Généralement on aime à faire part de ses découvertes, et ceux qui font des collections n'ont pas de plus grand plaisir que de montrer le résultat de leurs recherches. De là à la formation de sociétés locales ou régionales, dans lesquelles chacun apporte son contingent d'information curieuse aussi bien qu'utile, il n'y a qu'un pas. A cet égard l'*Ottawa Field Naturalist Club* est un exemple aussi encourageant qu'il est facile à imiter.

C'est ici que pourrait intervenir avec profit notre Société Royale, dont un des résultats les plus avantageux, comme l'a fort judicieusement fait remarquer notre dévoué secrétaire, M. Bourinot, est d'encourager les sociétés scientifiques dispersées dans tout le pays, en même temps qu'elle peut devenir, pour ces sociétés, l'intermédiaire de la publication des travaux coordonnés de leurs membres.

Ce que j'ai dit en prenant pour exemple les sciences naturelles, peut se dire, comme de raison, de toutes les autres branches des connaissances humaines.

Verrons-nous bientôt ce réseau de travailleurs et de sociétés locales couvrir tout notre immense et magnifique pays? C'est un trop beau rêve pour qu'il se réalise; mais hâtons-nous de dire qu'il n'est pas nécessaire que ce plan s'exécute dans son entier. Si l'on ne peut trouver cent travailleurs, tâchons d'en susciter dix. La noble contagion de l'étude et du travail utile se propagera petit à petit. Faisons donc autour de nous une propagande aussi active que possible; et si, en moyenne, chacun des membres de la Société Royale détermine un seul travailleur de bonne volonté à se mettre à l'œuvre, nous aurons assurément bien mérité de la patrie. J'ajoute que nous aurons aussi bien mérité de la religion: car chaque travailleur arraché ainsi à l'oisiveté est une conquête faite sur les mauvaises passions, vu que celles-ci sont le plus souvent incompatibles avec la noble passion de l'étude.

The Society then adjourned at the call of the Council, in order to give an opportunity for the meeting of the respective sections.

SESSION III. (*May 28th.*)

The Society was called to order at 3 o'clock by the President.

Reports from Affiliated Societies. (*Continued.*)

X.—From the Société Historique de Montréal, through M. Garneau:—

La Société Historique de Montréal se réjouit à juste titre de voir un de ses membres élevé à la haute dignité de cardinal. Son Eminence Mgr Taschereau, alors prêtre du séminaire de Québec, avait bien voulu devenir un de nos premiers membres. Comme la Société Historique en était encore à ses

débuts, elle fut sensible à l'honneur de pouvoir compter dans son sein un homme déjà remarquable par sa science et par son amour pour les études historiques. Nous ne doutons pas que Son Eminence ne profite de sa position élevée pour favoriser les recherches relative à l'histoire du Canada, comme elle l'a déjà fait d'ailleurs pendant son dernier voyage à Rome.

Si nous avons des motifs de nous réjouir, nous en avons aussi de nous attrister en voyant les rangs des anciens membres s'éclaircir. Cette année, nous avons eu à regretter la perte de M. le juge Loranger, qui prenait, surtout depuis quelques années, une part active à nos délibérations.

Depuis son dernier rapport, la Société a continué de s'occuper de la publication d'un premier cahier du livre d'ordres des campagnes de 1755-59. L'impression vient d'en être terminée, et le volume sera bientôt distribué. Nous publierons l'année prochaine les ordres de la campagne de 1756.

Notre bibliothèque s'est enrichie de plusieurs pièces manuscrites, offertes par M. le juge Baby. Ces pièces se rapportent au commerce de la colonie dans les premières années qui ont suivi la conquête. Grâce à la générosité de plusieurs membres, nous avons augmenté considérablement nos collections de *Factums* de la cour d'appel, de brochures et de documents parlementaires. Nos échanges avec le *Smithsonian Institute* nous ont permis de compléter plusieurs publications importantes. Cependant nous sommes forcés d'avouer que nous n'avons encore, en fait d'ouvrages sur l'histoire du Canada, que ceux qui sont considérés comme indispensables.

Le président a continué de faire copier soit au greffe de cette ville, soit ailleurs, les pièces qui ont rapport à l'histoire particulière de Montréal.

Il est peut-être encore plus utile en ce moment de recueillir des documents que de les publier, ou d'acheter des livres. C'est pourquoi la Société Historique de Montréal prie la Société Royale de vouloir bien user de son influence auprès du gouvernement fédéral, afin que celui-ci fasse copier — mais avec toute l'exactitude possible — les documents dont l'importance pour notre histoire lui a été signalée.

XI.—From the Natural History Society of Montreal, through Mr. Alfred Henry Mason:—

It is my privilege to have the honour to report to this distinguished Society the work done by the members of the Natural History Society of Montreal during the past session 1885-86:—

The Society has held five meetings, at which the following original papers have been read:—

1. The Origin of the Ainos and their final Settlement and Distribution in Japan, by Prof. Penhallow.
2. Boulder drift and Sea Margins at Little Metis, by Sir William Dawson.
3. Pleistocene Fossils of Anticosti, by Lt.-Col. Grant.
4. Exploration of some Mounds in the Northwest, by C. N. Bell.
5. Description of New Fresh-Water Sponges, by A. H. MacKay.
6. The Hydration of Wood Tissues in Trees and Shrubs, by Prof. Penhallow.
7. The danger of Poisoning from the Commercial Uses of Arsenic, by Dr. J. Baker Edwards.
8. The Physical Characteristics of the Ainos, by Prof. Penhallow.
9. Canadian Minerals, by Dr. Harrington.
10. Our Northwest Prairies: their Origin and their Forests, by A. T. Drummond.
11. The Forests of Canada, by Dr. Robert Bell.
12. The Protection of North American Birds, by Alfred H. Mason.
13. Polyembryony, by Prof. Penhallow.

Most of these papers have been printed in the *Canadian Record of Science*, a journal published by the Society, the editors being members of the Society, and their services voluntary. Five hundred copies of this journal are published quarterly, 350 being distributed amongst the members and in exchanges. The Society exchanges Proceedings with the scientific publications in Canada, with 23 in the United States, 87 in Great Britain, 25 on the Continent of Europe, and one in Australia. These exchanges are available for the use of the members.

The Society provides six original scientific Lectures during the Winter months, called the "Somerville Course of Lectures," and the public are admitted free. The following lectures were delivered by members of the Society last session, and as there are no fees, the whole work is a labour of love:—

1. Antiseptics and Disinfectants, by Alfred H. Mason.
2. The Chalk Formation, by Rev. W. J. Smyth.
3. The Source of Igneous Rocks, by Thos. Macfarlane.
4. The Chemistry of Bread and other Farinaceous Foods, by Dr. Casey A. Wood.
5. Cotton and Cotton Manufactures, by Wm. Hobbs.
6. Breathing and Ventilation, by Dr. J. B. McConnell.
7. The History of a Modern Volcano, by Sir William Dawson.

The Society has a Museum, which is open to the public daily, at a nominal charge, and to members and their families free. It comprises objects in four different departments of science—zoology, botany, geology and mineralogy; also miscellanies and antiquities. Several contributions have been added during the past session.

The Library contains over 3,000 volumes of publications in accord with the objects of the Society; amongst these are many very rare books, not to be found in any other library in Canada. During the past session, the whole of the books have been overhauled, classified and numbered, and a complete catalogue is in course of compilation.

For some years, the Society has received material assistance in the good work it is doing from the Provincial Government. The Council regret that this grant has recently been withdrawn, and if any of the members of this, the foster-daughter of Canadian scientific societies, can influence the restoration of this grant, we respectfully ask your sympathy and coöperation.

XII.—From the Nova Scotian Institute of Natural Science, through Prof. A. H. MacKay.

This session of the Nova Scotian Institute of Science has produced as large a number of papers on subjects connected with Natural Science as usual, shewing that in the twenty-fourth year of its existence it is still vigorous. It has been called upon to mourn the loss of its late esteemed President, Robert Morrow, one of its most zealous workers in comparative anatomy, whose papers have contributed much to the value and interest of the Proceedings and Transactions of the Institute. Dr. John Somers has succeeded as President.

List of papers read during the session, 1885-6:—

1. Additional Notes on Glacial Action, at Bedford Basin, Halifax Harbour, and North-west Arm, by Dr. Honeyman.
2. New Plants of Nova Scotia, by Dr. Somers.
3. On the Relative Bulk of certain Aqueous Solutions and their Constituent Water, by Dr. MacGregor.
4. Sable Island, its probable Origin and Submergence, by Simon D. Macdonald.
5. Additions to former list of Plants collected in the vicinity of Truro, N. S., 1885, by G. G. Campbell.
6. Fungi of Novia Scotia, by Dr. Somers.
7. The Carboniferous of Cape Breton, by Edwin Gilpin.
8. Notes of a Polariscopic Examination of Crystalline Rocks of Antigonish County, N. S., by Dr. Honeyman.
9. Observations on the Currents of the Gulf of St. Lawrence, by John J. Fox.
10. Notes on the Anatomy of *Delphinus delphis*, by Dr. Somers.
11. Geology of Antigonish County reviewed, by Dr. Honeyman.

12. Additions to the Catalogue of Nova Scotian Fishes, etc., by Dr. Honeyman.

13. On Specimens of Labrador Duck in the McCulloch Museum, Dalhousie College, by Andrew Downs.

XIII.—From the Historical and Scientific Society of Manitoba, through Prof. Bryce.

The Historical and Scientific Society of Manitoba has just completed the seventh year of its existence, the last year having been the most vigorous.

One of its first aims was to establish a Reference Library of Canadian and Northwest Literature. It has now, in this department, 300 volumes, so that with the private library of the President, and that of the Province, almost any books necessary for prosecuting the study of Canadian history are procurable in Manitoba. During the past year, the Society has combined its Library with that of the University of Manitoba, the Isbister Library of 4,400 volumes, and has taken charge of the whole. The Society has consequently some 11,000 volumes in its rooms, which form the chief place of resort in Winnipeg, for those of literary or scientific inclinations. During the year, special steps have been taken to increase the Natural History and Archæological Museum of the Society. Communication has been opened with some hundreds of persons scattered from Lake Superior to the Rocky Mountains, and promises have been given of additional articles in Indian work, as well as fossils from the Silurian, Cretaceous, and Laramie formations During the year, a small amount was devoted to following up the explorations of the aboriginal mounds, which have been going on for several years under the auspices of the Society. Invitations have been given to the Society to visit different mound regions, especially one group of twenty, seemingly fortification mounds, which were so remarkable as to have attracted the attention of Prof. Hind in his flying visit through the south of Rupert's Land, in 1858. The Society has had, during the past year, its most successful year so far as papers are concerned, almost all of them being the results of original research. They were as follows:—

Session of 1884-5.

1. Galileo, by Ex-Judge Ryal.
2. Ethnology of Alaska, by Mr. J. Hector Inkster.
3. Hudson Bay, by Dr. Walton Haydon.

Session of 1885-6.

1. The Old Settlers of Red River. Inaugural lecture by the President, Dr. Bryce.
2. Economic Minerals of the Northwest, by Mr. A. McCharles.
3. Geology of Lake Winnipeg, by Prof. J. H. Panton.
4. British Columbia, by Mr. Walter Moberly.
5. Time-Marking, by Mr. R. E. W. Goodridge.
6. Chinook Winds, by Mr. A. Bowerman.
7. Characteristic Mammals of the Northwest, by Mr. E. E. T. Seton.
8. The Celt in the Northwest, by the President.

The Society is indebted to the Provincial Government, and to the city of Winnipeg, for the continuance of grants, one of $250 and the other of $500.

It has also received bountiful recognition from the Hon. Sir Donald A. Smith, Messrs. C. J. Brydges, J. H. Ashdoun, F. W. Stobart, Commissioner Wrigley and others.

The receipts of the Society for the year were some $2,300, there being a small balance on hand at the end of the year. The financial affairs of the Society have been well managed, and are in a flourishing condition. Exchanges are maintained with all the leading societies in Great Britain, United States and Canada.

A number of the members of the Society are much interested in a project submitted to the

Royal Society by our President in his "Plea for a Canadian Camden Society," two years ago. The plan suggested the feasibility of printing, say two or three works a year, under the auspices of the Royal Society, by a system of subscriptions. Unpublished manuscripts, early books out of print, and the material needed for historical study can be had in abundance to make such a scheme successful. In the Parliamentary Library, Ottawa, there is in manuscript the travels of Alexander Henry, Jun., which are most valuable for the Northwest history of 1800-10. There is in private hands the Journal of David Thompson, Astronomer of the North-West Company of Montreal. Mr. Thompson, from whom Thompson River, British Columbia, was named, was, about the beginning of this century, one of our most adventurous and successful explorers. He died at Williamstown, Glengarry County. In the Hudson's Bay Co.'s Library, London, there is a manuscript of the explorer in the French times, Pierre Radisson; also that of Peter Fidler, of the Hudson's Bay Co.

If some energetic bookseller were to undertake the matter, under the direction of a Committee of the Royal Society, no doubt, with the coöperation of the affiliated societies, subscriptions could be got which would make the scheme self-sustaining from the beginning.

Our Society would earnestly urge the matter on the attention of the Royal Society.

XIV.—From the Ottawa Literary and Scientific Society, through Mr. Wm. P. Anderson:—

I have the honour again to represent the Ottawa Literary and Scientific Society as its delegate, and to submit its report of work done since the last meeting.

The year has been for the Society an uneventful one, consequently there is little of interest to submit. The usual routine work has been gone through with a fair measure of prosperity, and the reading-room and library have been efficiently maintained, the reading-room especially being well patronised, and containing a great many of the best newspapers and periodicals.

On behalf of the Society, I beg to extend to all the Fellows of the Royal Society a most cordial invitation to use our library and reading-room, 25 Sparks Street, during their present visit. The necessity for some less formal meeting room than the reading-room, where conversation could be freely indulged in, had long been felt. It was, in consequence, lately determined to prepare an extra room for that purpose, and it is hoped that this action will have the effect of extending our social influence, and also of inducing the chess-players of the city to make our rooms their headquarters.

During the winter a programme of lectures was prepared, and these were delivered for the most part to large audiences. It was deemed expedient to enlist our staff of lecturers wholly from residents in the city, and this new departure was attended with a gratifying measure of success.

The plan which has been followed for two or three years past, of inviting short essays from the younger members of the Society, on this occasion produced two or three exceptionally brilliant papers, and proved the wisdom of thus encouraging rising literary ability. The following is a list of the lectures and addresses given:—

1. Inaugural address on Science in Canada, by the President, Mr. William P. Anderson.
2. The Rocky Mountains and what I saw in them, by Prof. Macoun.
3. A Study of Thackeray, by Mr. Martin J. Griffin.
4. The Hudson Bay Territories and their Inhabitants, by Dr. Robert Bell.
5. Travels in the South Seas, by Mr. F. N. Gisborne.
6. A Topic of the Times, by the Hon. Wm. McDougall, C.B.
7. Gaspé Peninsula, past and present, by Mr. R. W. Ells.
8. Nathaniel Hawthorne and his Writings, with illustrative readings, by Mr. J. M. Oxley.
9. Is Vivisection, or Experimentation on the Lower Animals, justifiable? by Dr. R. M. Powell.
10. Byron, by Mr. A. Lampman.
11. Edgar Allan Poe, by Mr. A. W. Gundry.

The Society at present occupies rooms of which the lease will expire in about two years' time, and as their value is steadily increasing, we find ourselves face to face with the problem of having to find new quarters. The advisability of having a building owned by the Society is sufficiently apparent, but heretofore the encouragement offered in Canada for the pursuit of literary or scientific studies has not been very great, and without any endowment, or the prospect of securing any, the outlook is far from hopeful.

I would suggest that the Royal Society might in some degree help to influence public opinion favourably, in the direction of supporting more generously societies whose only aim is the intellectual improvement of the citizens.

Our best prospects of securing a building are by uniting with other associations in the city having kindred objects, such as the Field Naturalists' Club and the local Art Association, and by joint effort putting up a building which will accommodate all the several Societies; to this end our efforts must be directed during the coming year.

The annual election of officers for the ensuing year took place on April 30th last, with the following result:—

President	Wm. P. Anderson.
First Vice-President	W. D. LeSueur.
Second " "	J. P. Featherston.
Secretary	F. K. Bennetts.
Treasurer	J. R. Armstrong.
Librarian	J. H. Brown.
Curator	H. M. Ami.
Members of Council	O. J. Jolliffe. D. Ewart. J. C. Kearns.

RESOLUTIONS.

The following Resolutions were then adopted:—

1. That the Council be instructed to consider the method of electing members under Section 6 of the Rules and Regulations, and to recommend to the Society, at its next General Meeting, such amendments as may seem desirable. (On the motion of Sir W. Dawson, seconded by Mr. T. Macfarlane.)

2. That the thanks of this Society be communicated to the Speakers of the Senate and the House of Commons, for the accommodation and facilities afforded to its members during the present General meeting. (On the motion of Mr. George Stewart, Jun., seconded by Abbé Casgrain.)

3. That the Society tenders its acknowledgments to the Literary and Scientific Society, and the Field Naturalists' Club of Ottawa, for the courtesies extended to its members during their present visit to this city. (On the motion of Sir W. Dawson, seconded by Very Rev. T. E. Hamel.)

REPORT OF SECTIONS.

The following Reports of Sections were then presented, in accordance with usage:—

Rapport de la Section I.

Nous avons l'honneur de soumettre le rapport de la section française :—

1. Nous regrettons que le nombre des membres qui ont pu assister cette année à nos séances soit si faible. Ils étaient 15 en 1882, — 8 en 1883, — 12 à l'assemblée de Québec, et 14 à celle d'Ottawa, en 1884, — et 13 en 1885. Nous n'étions que sept cette année, ce qui ne doit pas pourtant prouver que

nous prenons moins d'intérêt aux travaux de la Société, car deux de nos membres sont en Europe en mission officielle; deux sont députés à l'assemblée législative de Québec, qui est maintenant en session; quatre sont retenus à Québec par leur devoir de membres et de secrétaire du conseil de l'Instruction publique, lequel s'est réuni hier le 26; un autre préside la cour supérieure qui siège en ce moment; deux ont envoyé des excuses qui ont été acceptées par notre section; les deux autres n'ont pas envoyé de lettres, mais nous savons que l'un d'eux est paralytique.

2. Les travaux qui ont été lus sont au nombre de dix; cinq se rapportent à l'histoire, trois sont des œuvres poétiques; un autre est l'éloge du regretté M. Oscar Dunn, fait par son successeur, d'après la coutume suivie dans l'Académie française; le dernier traite un point préhistorique.

3. Notre section recommande l'insertion de sept de ces travaux dans les mémoires de la Société Royale.

4. La section française a remarqué avec regret que l'on n'a pas obéi cette année à l'injonction de la Société, exigeant que le titre français fût imprimé sur le dos de nos mémoires comme le titre anglais.

5. Tout en remerciant le parlement pour la gracieuse permission qu'il nous donne de siéger dans ses chambres, nous exprimons le désir que la Société Royale puisse bientôt tenir ses séances dans des chambres à elle.

6. La section française désire pouvoir accorder trois diplômes chaque année à des personnes qui n'appartiennent pas à la Société. Son but est d'encourager le talent des jeunes gens et les études sérieuses en histoire, littérature, archéologie, etc. Les membres de la section paieraient de leur bourse le coût de ces diplômes, et ceux-ci seraient signés par le président et le secrétaire de la section, et contresignés par le président et le secrétaire généraux.

7. Les élections ont eu lieu ce matin. Ont été élus: —

Président — Paul de Cazes.
Vice-président — Pamphile LeMay.
Secrétaire — Alphonse Lusignan.

Le tout humblement soumis.

Benjamin Sulte, *président.*
A. Lusignan, *secrétaire.*

Report of Section II.

I have the honour to report that Section II has elected as office-bearers for the ensuing year:—

R. M. Bucke, M.D., *President.*
Wm. Kirby, *Vice-President.*
George Stewart, Jun., *Secretary.*

The Committee on Publications is composed of Dr. Daniel Wilson, John George Bourinot and George Stewart, Jun.

The Committee appointed last year to consider the question of publishing memoirs, or old books relating to Canadian history, travel, etc., under the auspices of the Royal Society, was reappointed. The Committee is composed of John George Bourinot, *Chairman;* John Reade, John Lesperance, and George Stewart, Jun.

The Secretary formally notified the Section that Mr. Charles Sangster had resigned his membership of the Royal Society. In accordance with Rule 6, a nomination to fill his vacancy was made and submitted to the Council.

The following papers were read:—

I. Caractacus, the British Hero, a poem. By Rev. A. McD. Dawson, LL.D.
II. Some Prehistoric Remains in Manitoba. By Chas. N. Bell, F.R.G.S.
III. Mair's Tecumseh. By Lieut.-Col. G. T. Denison, LL.B.
IV. The Right Hand. By Daniel Wilson, LL.D.
V. The Wilderness Missions of Canada. By Rev. Dr. Withrow.
VI. Local Government in Canada. By J. G. Bourinot, F.S.S.
VII. Historical Record of the St. Maurice Forges. By F. C. Wurtele.
VIII. The Lost Atlantis. By Daniel Wilson, LL.D.
IX. Some Notes on Canadian Ethnology. By John Reade.
X. The Emotions, their place in Mind. By Prof. Wm. Lyall, LL.D.
XI. Noted Journeys in Rupert's Land and Beyond. By Prof. J. Bryce.
XII. Malcolm and Margaret, a poem. By Rev. A. McD. Dawson, LL.D.

I have the honour to be, Sir,

Your obedient servant,

George Stewart, Jun., *Secretary.*

Report of Section III.

The number of members of the Section in attendance was ten. The absent members were Profs. Bayne, Cherriman, Dupuis, Haanel, Johnson, MacGregor and Loudon, Drs. Fortin and Girdwood, and Mr. C. Baillairgé.

The following papers were read, in full or in abstract, before the section:—

I. Presidential Address. By C. Carpmael, M.A.
II. The Genetic History of Crystalline Rocks. By T. Sterry Hunt, M.A., LL.D., F.R.S.
III. Supplement to "A Natural System in Mineralogy." By T. Sterry Hunt, M.A., LL.D., F.R.S.
IV. The Colouring Matter of Black Tourmalines. By E. J. Chapman, Ph.D., LL.D.
V. Some Canadian Minerals. By B. J. Harrington, B.A., Ph.D.
VI. A Meteorite from the Northwest. By A. G. Coleman, Ph.D., communicated by Prof. Haanel. (Read by C. Carpmael.)
VII. Some Points in reference to Ice Phenomena. By Robert Bell, M.D., LL.D.
VIII. Paper on Time-Reckoning for the Twentieth Century. By Sandford Fleming, C.M.G., C.E.
IX. Le choix d'une projection pour la carte du Canada. By E. Deville, Surveyor General.
X. Abel's Forms of the roots of solvable equations of the fifth degree. By G. Paxton Young, M.A. (Read by C. Carpmael.)
XI. Conditions of the Solvability of Ejections of prime degrees—Kronecker's law. By G. Paxton Young, M.A. (Read by C. Carpmael.)

The following resolutions were passed:—

(1). "That the Council be requested to continue to coöperate with the Committee of the British Association in soliciting the attention of the Government to the important matter of Observations on Tides and Currents of the Atlantic and Pacific coasts."

(2). "That the Council be requested to memorialize the Government on the subject of the erection, at Ottawa, of a suitable building for a National Museum, in connection with the Geological and Natural History Survey of the Dominion, and with accommodation for this Society, and for a Library."

(3). "That this section recommends to the favorable consideration of the Council the proposal to assist Dr. Franz Boas, of Berlin, pecuniarily or otherwise, in his further explorations in Baffin Land, during the present year."

The officers elected for the ensuing year were:—

MR. T. MACFARLANE, M.E., *President.*
MR. SANDFORD FLEMING, C.M.G., C.E., *Vice-President.*
MR. G. C. HOFFMAN, F. Inst. Chem., *Secretary.*

CHARLES CARPMAEL, *President.*
G. C. HOFFMAN, *Secretary.*

Report of Section IV.

The number of members of the Section attending the meeting was eight; but Mr. G. F. Matthew, who was not able to be present, sent two papers to be read.

The following is a list of papers which were read, in full or by title:—

I. Presidential Address on the Obligation of Geological Science to Canada. By SIR WILLIAM DAWSON.
II. The Fossil Flora of the Laramie Series of Western Canada. BY SIR WILLIAM DAWSON.
III. Une Étude Géologique sur les phénomènes de contact entre les formations Siluriennes et Archéennes de la Province de Québec. By ABBÉ J. C. K. LAFLAMME.
IV. Quelques notes sur la pureté de la glace des rivières, exposant surtout le résultat des travaux que j'ai faits à Québec dans le cours de l'hiver. By ABBÉ J. C. K. LAFLAMME.
V. Some recent additions to the list of Canadian Ferns. By DR. T. G. W. BURGESS.
VI. On the Cambrian Faunas of Cape Breton and Newfoundland. BY G. F. MATTHEW.
VII. Illustrations of the Fauna of the St John Group. By G. F. MATTHEW.
VIII. The Silurian System of Northern Maine, New Brunswick and Quebec. By PROF. L. W. BAILEY.
IX. Notes on the Glaciation and Pleistocene Subsidence of Northern New Brunswick and South-eastern Quebec. By R. CHALMERS, communicated by DR. G. M. DAWSON.
X. On some Marine Invertebrata, etc., from the coast of British Columbia. By J. F. WHITEAVES.
XI. Illustrations of the Fossil Fishes of the Devonian rocks of the Dominion. Part I. By J. F. WHITEAVES.
XII. List of the Crustacea collected by Dr. G. M. Dawson on the coast of British Columbia in 1885. By PROF. S. J. SMITH, of Yale College, communicated by J. F. WHITEAVES.
XIII. On certain borings in Manitoba and the Northwest Territories. By DR. G. M. DAWSON.
XIV. Notes on some points in Arctic American Geology. By Dr. G. M. DAWSON.
XV. Notes on the Carboniferous marine limestone formation of the East River, Pictou County, N. S. By E. GILPIN, JUN.
XVI. Preliminary Report on some Graptolites from the Lower Palæozoic rocks on the south side of the St. Lawrence from Cap Rosier to the Tartigo River, from the rocks of Orleans Island, Cap Rouge, and the Cove fields, Quebec. By PROF. CHARLES LAPWORTH, LL.D., (of Mason College, Birmingham, England), communicated by J. F. WHITEAVES.
XVII. Mechanism of Movement in Cucurbita, Vitis and Robinia. By PROF. D. P. PENHALLOW.

The following resolution was passed unanimously by the section:—"That the Council be requested to memorialize the Government on the subject of the erection at Ottawa of a suitable building for a National Museum, to embrace the accommodation necessary for the Geological and

Natural History Survey of the Dominion, and for this Society and its Library, and respectfully to urge that, in view of the present insufficiency of the building of the Survey, and of the need of further provision for the adequate display of economic as well as scientific specimens, and of the preservation of ethnological remains, the erection of such a building is a matter of much importance to the welfare and reputation of the Dominion."

The election of officers of the Section for the ensuing season resulted as follows:—

President, Rev. Prof. Laflamme.
Vice-President, Dr. R. Bell.
Secretary, J. F. Whiteaves.

J. F. Whiteaves, *Secretary.*

Election of Officers.

The Society then proceeded to the election of officers for the year 1886-7, and the following gentlemen were nominated and unanimously elected:—

President.—Very Rev. T. E. Hamel, M.A.
Vice-President.—G. Lawson, Ph.D., LL.D.
Honorary Secretary.—J. G. Bourinot, F.S.S.
Honorary Treasurer.—J. A. Grant, M.D., F.G.S.

The thanks of the meeting were then voted to the retiring officers for their assiduity in furthering the interests of the Society during the past twelve months.

The Society then adjourned.

THE ROYAL SOCIETY OF CANADA.

FOUNDER: THE RIGHT HONOURABLE THE MARQUIS OF LORNE.

OFFICERS FOR 1886-87.

HONORARY PRESIDENT AND PATRON:

HIS EXCELLENCY THE MOST HONOURABLE THE MARQUIS OF LANSDOWNE, G.C.M.G.

GOVERNOR-GENERAL OF CANADA.

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ANNÉE 1886

I — *Le Pionnier*,

Par LOUIS FRÉCHETTE.

(Lu le 25 mai 1886.)

J'ai bien connu jadis le vieux Baptiste Auclair.
C'était un grand vieillard jovial, ayant l'air
Déluré d'un ancien capitaine en retraite.
Autrefois au Nord-Ouest il avait fait la traite,
Et sa fortune aussi, disait-on dans le temps ;
Mais on n'en était pas bien sûr, car à trente ans
Il était retourné, sans le moindre étalage,
Reprendre la charrue et sa place au village,
Héritier de la terre et du toit paternels.
C'est là que je l'ai vu, dans les jours solennels,
Rieur, et se faisant craqueter les jointures,
Nous raconter ce qu'il nommait ses aventures.

Il avait élevé seize enfants : huit garçons
— Là-dessus je ne sais plus combien de bessons —
Et huit filles, tous seize installés en ménage.
Il n'en portait pas moins gaillardement son âge.
— J'ai, disait-il, bon pied bon œil, et sapristi !
Sans me vanter, jamais je ne me suis senti
Si jeune et si dispos que lorsque la cohorte
De mes petits-enfants vient frapper à ma porte.
Et j'en ai, Dieu merci, cent dix-sept bien comptés !
Beau chiffre, n'est-ce pas ? Tenez, vous plaisantez,
Vous autres, lorsque vous discutez politique,
Nation, avenir ; l'œuvre patriotique,
Jeunes gens, c'est la mienne ! Un homme est éloquent,
Et peut se proclamer bon patriote... quand ?
Quand il a cinquante ans labouré la prairie,
Et donné comme moi cent bras à la Patrie.
Mettez cela dans vos papiers, beaux orateurs !

Et, parcourant des yeux son cercle d'auditeurs,
Il éclatait de rire attendant la réplique.

Le vieillard conservait une étrange relique
Au fond d'un vieux bahut à moitié ruiné ;
Il tenait ce trésor de son père, et l'aîné
De ses enfants devait en avoir l'héritage....
Il ne lui plaisait pas d'en dire davantage.

Un beau soir cependant qu'on le sollicitait,
Il étala l'objet devant nos yeux ; c'était
Un petit vêtement de gros chanvre, une espèce
De chemise d'enfant, lourde, grossière, épaisse,
Mal cousue, et portant sur son tissu taché
Quelques traces d'un brun noirâtre et desséché.

— C'est là du sang, Messieurs, du sang de race fière !
Dit le vieillard. Et puis, roulant sa tabatière
Entre ses doigts noueux, il nous fit le récit
De la simple et navrante histoire que voici :

Ce fut un temps bien rude et plein d'âpres angoisses
Que les commencements de ces belles paroisses
Qu'on voit s'échelonner aujourd'hui sur nos bords.
Quand, du haut du vaisseau qui s'ancre dans nos ports,
Le voyageur charmé se pâme et s'extasie
Au spectacle féerique et plein de poésie
Qui de tous les côtés frappent ses yeux surpris,
Il est loin, oui bien loin de se douter du prix
Que ces bourgs populeux, ces campagnes prospères
Et leurs riches moissons coûtèrent à nos pères.
Chez nous, chaque buisson pourrait dire au passant :
Ces sillons ont moins bu de sueur que de sang.
Par quel enchaînement de luttes, de souffrance,
Nos aïeux ont conquis ce sol vierge à la France,
En y fondant son culte immortel désormais,
La France même, hélas ! ne le saura jamais.

Quels jours ensanglantés ! quelle époque tragique !
Ah ! ce fut une race à la trempe énergique
Que les premiers colons de ce pays naissant.
Ils vivaient sous le coup d'un qui-vive incessant :
Toujours quelque surprise, embûche, assaut, batailles !
Quelque ennemi farouche émergeant des broussailles !
Habitants égorgés, villages aux abois,
Prisonniers tout sanglants entraînés dans les bois !...
Les femmes, les enfants veillaient à tour de rôle,
Tandis que le mari, le fusil sur l'épaule,

Au pas ferme et nerveux de son cheval normand,
Semeur de l'avenir, enfonçait hardiment
Dans ce sol primitif le soc de sa charrue ;
Et si, l'été suivant, l'herbe poussait plus drue
Dans quelque coin du pré, l'on jugeait du regard
Qu'un cadavre iroquois dormait là quelque part.
Personne n'en faisait de cas, c'était la mode.

Mais arrivons de suite au sanglant épisode
Conté par mon ami le vieux Baptiste Auclair.

Au penchant d'un talus baigné par le flot clair
Où le beau Nicolet, à trente arpents du fleuve,
Mire aujourd'hui gaîment sa cathédrale neuve,
A l'ombre d'un bouquet de pins au faîte altier,
Que les siècles n'ont pu terrasser tout entier,
Trois de ces pionniers, en ces jours de tourmentes,
Avec l'espoir prochain de saisons plus clémentes,
Avaient planté leur tente à la grâce de Dieu.

L'un d'eux se nommait Jacque. Il avait dit adieu
Aux droits, à la corvée, à la taille, aux gabelles,
Pour s'en venir chercher, avec d'autres rebelles,
Sous des cieux où le fisc n'eût pas encore lui,
Un peu de liberté pour les siens et pour lui.
Sa femme, une robuste enfant de Picardie,
Trois fois avait doté leur famille agrandie
D'un nouveau-né gaillard, alerte et bien portant.
Et l'œil des deux époux allait à chaque instant,
Avec un long regard, hélas ! souvent morose,
Des aînés tout brunis au bébé frais et rose.

Or ce dernier n'avait que six mois seulement,
Lorsque se déroula l'affreux événement
Qui sur un lit d'horreurs le jeta seul au monde.

Pour les colons l'année avait été féconde.
La pente des coteaux et le creux des vallons
Etalaient, souple et lourd, un manteau d'épis blonds
Qui, comme un lac doré que le soleil irise,
Flottait luxuriant au souffle de la brise.
L'heure de la moisson était venue ; aussi
Le cœur des défricheurs, oubliant tout souci,
Montait reconnaissant vers Celui dont l'haleine
Féconde les sillons et fait jaunir la plaine.

Un soir, notre ami Jacque, après mûr examen,
Prépara sa faucille, et dit : — " C'est pour demain ! "
Puis il pria longtemps et dormit comme un juste.

Hélas ! si par hasard, ce soir-là même, juste
A l'heure où les colons se livraient au sommeil,
En amont du courant, prêt à donner l'éveil,
Quelqu'un eût côtoyé la rive solitaire,
Il eût sans doute vu, furtifs, rasant la terre
Dans l'ombre de la berge, et pagayant sans bruit,
Trois longs canots glisser lentement dans la nuit.
C'étaient les Iroquois — ces maraudeurs sinistres
Dont les premiers feuillets de nos anciens registres
Racontent si nombreux les exploits meurtriers.
Rendus non loin des lieux où nos expatriés
Avaient fortifié leur petite bourgade,
Dans un enfoncement propice à l'embuscade,
Ils prirent pied, masqués par un épais rideau
De branchages touffus inclinés à fleur d'eau,
Puis sur le sable mou halèrent en silence
Leurs pirogues au fond le plus obscur de l'anse,
Et, sous les bois, guettant et rampant tour à tour,
Tapis dans les fourrés, attendirent le jour.

Celui-ci se leva radieux et superbe.

C'est fête aux champs le jour de la première gerbe :
Aussi nos moissonneurs, les paniers à la main,
Dès l'aube, tout joyeux, se mirent en chemin.
Les aînés, que la mère avec orgueil regarde,
S'avançaient, tapageurs, en piquet d'avant-garde,
Tandis que Jacque, ému, riait d'un air touchant
Au petit que sa femme allaitait en marchant.
Car, suivant la coutume, on était en famille.

Bientôt, au bord d'un champ où l'épi d'or fourmille,
On fit halte. Partout, des prés aux bois épais,
Nul bruit inusité, nuls indices suspects,
Rien qui troublât la paix des vastes solitudes.
Du reste on n'avait nul sujet d'inquiétudes :
Pas une bête fauve, et, quant aux Iroquois,
Ils n'osaient plus tirer leurs flèches du carquois,
Refoulés qu'ils étaient au fond de leurs repaires.
On pouvait donc compter sur des jours plus prospères
Enfin, l'espoir au cœur, et ne redoutant rien,

Jacque — après avoir fait le signe du chrétien —
Près du marmot dormant au creux d'une javelle,
Commença les travaux de la moisson nouvelle.

Vous voyez le tableau : dans le cadre assombri
De l'immense forêt qui lui prête un abri,
Une calme clairière où l'on voit, flot mouvant,
Les blés d'or miroiter sous le soleil levant :
A genoux sur la glèbe, et tête découverte,
Les travailleurs penchés sur leur faucille alerte ;
Deux enfants poursuivant le vol d'un papillon ;
Et puis ce petit ange, au revers d'un sillon,
Parmi les épis mûrs montrant sa bouche rose...
C'était comme une idylle au fond d'un rêve éclose.

Qu'advint-il ? on ne l'a jamais su tout entier.

Ce matin-là, quelqu'un, en suivant le sentier
Qui conduisait du fort à la rive isolée,
Entendit tout à coup, venant de la vallée
Où Jacque était allé recueillir sa moisson,
Quelque chose d'horrible à donner le frisson.
C'étaient des cris stridents, aigus, épouvantables ;
Et puis des coups de feu, des plaintes lamentables,
Appels désespérés et hurlements confus
Frappant lugubrement l'écho des bois touffus.
Les farouches rumeurs longtemps se prolongèrent ;
Longtemps dans le lointain des clameurs s'échangèrent ;
Et puis, sur la rivière où le bruit se confond.
Succéda par degrés un silence profond....

Le soir, lorsque les deux colons du voisinage
Osèrent visiter la scène du carnage,
Un spectacle hideux s'offrit à leurs regards :
Trois cadavres sanglants, défigurés, hagards,
Jacque et les deux enfants, pauvre famille unie,
Dans une même horrible et fatale agonie,
Yeux crevés, ventre ouvert, le crâne dépouillé,
Gisaient là sur le sol par le meurtre souillé.
Quant à la femme, hélas ! elle était prisonnière ;
Sans doute condamnée à mourir la dernière
A quelque affreux gibet par l'enfer inventé.

On plia le genou sur le champ dévasté,
Et, de ces cœurs naïfs glacés par l'épouvante,

La prière des morts allait monter fervente,
Lorsqu'au *De profundis clamavi*, — faible et doux,
Un long vagissement venant on ne sait d'où
Répondit aussitôt comme un cri d'âme en peine.

Les colons étonnés retinrent leur haleine....

C'était comme un sanglot d'enfant ; et, stupéfait,
Quelques instants plus tard, on trouvait en effet,
Dans le creux d'un sillon, la face contractée,
Perdu sous un amas de paille ensanglantée,
Un enfant de six mois suffoquant à demi.
Sans doute que la mère avait de l'ennemi
Par cet ingénieux moyen trompé la rage,
Et, dévoûment sublime, avait eu le courage
De marcher à la mort d'un cœur déterminé,
Sans trahir d'un regard le pauvre abandonné !

— Or ce pauvre orphelin, ce pauvre petit être,
Fit le vieux plus ému qu'il ne voulait paraître,
Voici le vêtement qu'il portait ce jour-là ;
Et, si je le conserve avec respect, cela
Ne surprendra bien fort personne ici, j'espère,
Car cet enfant, c'était mon arrière-grand-père !

II — *Le golfe Saint-Laurent*

(1600-1625)

Par BENJAMIN SULTE.

(Lu le 26 mai 1886.)

I

Avant le premier voyage de Cartier (1534), les trafiquants français fréquentaient le golfe Saint-Laurent. La pêche et la traite des pelleteries y attiraient les armateurs. Lors de la visite de Champlain (1603), le troc s'avançait déjà dans le fleuve jusqu'au lac Saint-Pierre, et les nations situées plus à l'ouest en avaient connaissance.

Nous avons pris l'habitude de concentrer notre attention entre Montréal et Québec, durant la période de Champlain. Je me propose de reporter un instant la pensée du lecteur sur le bas du fleuve, principalement dans le golfe, au cours des vingt-cinq années qui s'écoulent de 1600 à 1625.

Si je ne soulève pas de problème intéressant, je pourrai du moins offrir un tableau des choses les plus ordinaires dans ces parages, et montrer que la lutte — car il y a toujours lutte en ce monde — avait lieu plutôt pour le commerce qu'en faveur de la colonisation. Le vaste et riche domaine maritime que comprenaient en ce moment les terres appelées la Nouvelle-France était tout, aux yeux des navigateurs et des hommes employés au négoce. Prendre au sérieux l'établissement de Québec et le Canada proprement dit, n'entrait point dans les idées du temps. De cette manière les efforts de la France, ou plutôt des Français, s'arrêtaient à la porte de notre pays. Le champ ainsi exploité satisfaisait les ambitions du grand nombre. Au-delà se trouvait l'avenir, que peu de personnes étaient en état d'apprécier. Une Nouvelle-France non seulement maritime mais terrestre — colonisée en un mot — paraissait comme un rêve aux yeux du vulgaire ; aussi Champlain était-il peu écouté, encore moins secouru.

L'amiral de Coligny, reprenant (1555) le travail de Roberval, avait voulu fonder une colonie stable. Il obtint l'assentiment d'Henri II ; mais on s'occupait alors de la Floride et du Brésil, d'où André Thevet revenait chargé de renseignements. Le Canada fut négligé encore une fois. Cartier venait de mourir. Nicolas Durand de Villegagnon conduisit ses compatriotes vers l'Amérique du Sud sans pouvoir les y fixer. Cet échec qui parut inexplicable, dans un pays regardé comme supérieur au Canada, ne pouvait que faire reculer l'idée coloniale, et c'est ce qui ne manqua pas d'arriver.

Mézeray, parlant de Villegagnon, dit qu'il " commença de faire voir aux Espagnols qu'ils ne seraient pas tout seuls les maîtres du nouveau monde." L'impression de Mézeray date de la fin du gouvernement de Richelieu, 1640 ; il est douteux qu'elle ait existé à la

cour de France vers 1560. Toutefois les Bretons, et avec eux la famille de Cartier, persistaient à se diriger du côté du Saint-Laurent, mais pour les fins du commerce uniquement. Les Anglais faisaient de même, sur une assez grande échelle, se tenant de préférence à Terre-Neuve, tandis que les Basques allaient au Cap-Breton, et les marins de Saint-Malo jusque dans le fleuve.

Pontgravé, Chauvin, de Chatte, Champlain, tentèrent en 1603 de créer le mouvement canadien. L'année suivante, Henri IV permit à toute les classes de la noblesse de se livrer au négoce sans déroger, aussi commencèrent-elles à entrer dans les compagnies anciennes ou qui se formaient dans cette vue ; elles y coudoyaient les gens de robe et les marchands-bourgeois, — ce qui était un spectacle nouveau.

Les Basques débitaient beaucoup de poisson sur les marchés de France. Ils tournèrent les regards des armateurs vers la région de l'Acadie. Le golfe Saint-Laurent était redouté des pilotes à cause de ses côtes dangereuses et des tempêtes qui y sévissent. De deux maux on choisit le moindre : l'Acadie fut préférée.

L'expérience personnelle des navigateurs tenait lieu de renseignements écrits ou publiés. Les cartes, s'il y en avait, était la propriété secrète de ceux qui les dressaient, à la suite de leurs propres voyages. Telle maison de commerce payait les services de pilotes et de capitaines qui possédaient des connaissances spéciales dans cet ordre de choses, et parvenait à réaliser de forts bénéfices en perdant moins de vaisseaux ou en trafiquant sur les côtes peu ou point connues de ses rivales. Tout était mystère pour les mariniers de l'Europe dans ce golfe immense, dans ces baies profondes, dans ces rivières étonnantes, dans ce fleuve rempli d'écueils et balayé par les ouragans. L'amitié des sauvages ne se partageait pas non plus également entre les races civilisées qui cherchaient à traiter avec eux. Chaque capitaine exerçait un prestige plus ou moins direct sur l'imagination des diverses tribus. C'est pourquoi la palme du succès revenait au plus habile navigateur et au plus adroit négociateur. La bravoure sous les armes et le génie militaire dans les combats étaient aussi des qualités de rigueur. Le pavillon de certains navires était plus respecté que celui d'un autre, à cause du chef d'équipage qu'il annonçait aux matelots étrangers comme aux indigènes.

Le trajet entre les deux continents se faisait rarement en ligne droite. Le P. Biard, parti de Dieppe en 1611, raconte qu'il toucha d'abord deux ou trois fois aux côtes d'Angleterre, puis descendit en longeant les terres de France jusque vers La Rochelle, où il fut tout surpris de voir le navire continuer sa route au sud jusqu'aux îles Açores, après quoi, virant de bord, il se dirigea vers le Cap-Breton. Ces zigzags se rencontrent dans plusieurs voyages de l'époque. Les marins m'ont dit, ajoute le P. Biard, que pour trois raisons ils descendent ainsi aux Açores : pour éviter la mer du Nord, pour s'aider des vents du sud, pour mieux calculer leur marche sur le soleil ; mais, dit-il de nouveau, je n'en veux rien croire. Ils descendirent jusqu'à 39° 30′ sans voir les Açores, et tournèrent, pour atteindre le grand banc de Terre-Neuve, qu'il estime large en quelques endroits de vingt-cinq lieues. " Sur le bord de ce grand banc, dit-il, les vagues sont d'ordinaire fort furieuses trois ou quatre lieues durant, et ces trois ou quatre lieues on appelle les Açores.... [1] Nous entrâmes dans les glaces sur les Açores du banc, degré du nord 46... et le cinq mai nous descendîmes à Canseau."

[1] L'imprimé que j'ai sous les yeux dit bien *Açores*, mais je pense qu'il faut mettre *accores*, contour d'un banc sous-marin ou d'un écueil. On dit aussi *écores*.

Le petit tableau qui suit met en regard quelques localités européennes et américaines qui se trouvent sur une même latitude tout en jouissant de températures très différentes :

50° — Ville de Dieppe. Milieu de la pointe nord de Terre-Neuve. Passage entre l'île d'Anticosti et la rive nord du fleuve Saint-Laurent. Ville de Winnipeg.
47° — Ville de Nantes. Sortie de la Loire. Passage entre Terre-Neuve et le Cap-Breton. Ville de Québec.
46° — Ville de La Rochelle. Pointe est du Cap-Breton. Ville de Sorel. Michillimakinac.
46°, 45°, 44° — Grand banc de Terre-Neuve. La Nouvelle-Ecosse. Montréal. Kingston.
43° — Saint-Jean-de-Luz, pays des Basques. Pointe sud de la Nouvelle-Ecosse. Portsmouth, entre Portland et Boston.
40° — Ville de Lisbonne, Portugal. Iles Açores. Ville de Philadelphie, Pensylvanie.

Donc, le P. Biard alla du 50° au 40°, et remonta au 46° pour arriver à Canseau, Cap-Breton. Ayant, si l'on veut, cent lieues à parcourir du nord au sud, il en avait fait quatre cents.

II

Au printemps de 1604, le sieur de Monts, partant pour fonder un poste en Acadie, confia un navire au capitaine Pontgravé, avec instruction de chasser de Canseau et des alentours du Cap-Breton les Français qu'il y rencontrerait faisant la pêche ou la traite. Pontgravé captura quelques Basques, mais on sait que cela ne suffisait pas pour arranger les affaires de son maître, lesquelles se gâtaient fort en ce moment. L'année suivante, le fondateur de Port-Royal se recommandait aux pêcheurs de morue pour se procurer les moyens de retourner en France ; ils lui brûlèrent la politesse, et de plus portèrent plainte à Henri IV, qui leur donna gain de cause.

Poutrincourt, qui obtint le privilège de de Monts, ne manqua pas, dès 1606, de recommander au même Pontgravé la saisie des bâtiments qu'il trouverait au Cap-Breton. Les navires de de Monts qui fréquentaient encore le golfe Saint-Laurent, à la suite d'une entente avec Poutrincourt, furent pillés à cette époque par des corsaires hollandais.

Sully, ambassadeur d'Henri IV, baissait pavillon, à trois lieues des rives de France devant la menace d'un simple brigantin de Londres. La marine anglaise tenait la mer, les Hollandais venaient en second lieu, les pirates d'Alger et de Tunis s'en mêlaient, les entrepreneurs de colonie, comme de Monts, n'avaient que des vaisseaux armés ; et de tout cela résultaient des hostilités continuelles.

Dans l'été de 1608, Pontgravé, se rendant à Québec, voulut arrêter des commerçants basques qui trafiquaient sur son chemin ; mal lui en prit car ils résistèrent, capturèrent son bâtiment, et blessèrent Pontgravé lui-même d'un coup de feu. La situation n'en était que plus mauvaise ; à peine commencées les colonies de Port-Royal et de Québec se voyaient entourées d'ennemis appartenant à quatre ou cinq nations aventureuses.

Pontgravé est le marin qui a le plus souvent parcouru le golfe Saint-Laurent, de 1600 à 1630. Sur des coquilles de quarante à cent tonneaux, il se lançait à travers l'océan et les dangers du grand fleuve, bravant le froid, les glaces, les vents, les compagnies hostiles, les corsaires, la famine, les révoltes de ses propres matelots, et faisant passer les Malouins partout, selon son cri de guerre connu. Si ce capitaine avait laissé des mémoires écrits,

ne serait-ce qu'un journal de bord, nous saurions beaucoup de choses qui se sont effacées du souvenir des hommes. A défaut de tels renseignements, tâchons de reconstruire une partie de ce passé déjà lointain.

Poutrincourt raconte que, retournant en Acadie, en 1610, un navire de forban fit mine de l'attaquer,[1] et ne se retira qu'après avoir constaté les forces du bâtiment français.

Il existait des pirates dans ces parages antérieurement à Poutrincourt. Remarquons cependant que la mort d'Henri IV, survenue le 14 mai 1610, inspirait une audace nouvelle aux écumeurs de mer. Jusque-là le roi de France était parvenu à contenir, dans une certaine mesure, les forbans des Etats barbaresques, ainsi que d'autres, qui leur aidaient dans les entreprises de ce genre. Lui mort, et la terreur de son nom dissipée, les pêcheurs du Saint-Laurent offraient une proie facile aux coups des Tunisiens et des Algériens.

Par le traité intervenu entre le sultan et Henri IV, "les Vénitiens, les Anglais, les Espagnols, les Portugais, les Catalans, les Ragusois, les Genevois, les Anconitains et les Florentins, et généralement toutes nations" pouvaient librement trafiquer dans l'empire turc "sous l'aveu et sûreté de la bannière de France, laquelle, dit le traité, ils porteront comme leur sauvegarde... obéissant aux consuls français... et d'autant que les corsaires de Barbarie, allant par les ports et havres de France, y sont reçus et secourus, et aidés à leur besoin de poudre et plomb et autres choses nécessaires à leur navigation, trouvant des vaisseaux français à leur avantage, ils ne laissent de les piller et saccager, en faisant les personnes esclaves, contre notre vouloir et celui du défunt empereur Méhémet notre père... commandons que les Français pris contre la foi publique soient remis en liberté.... Si les corsaires continuent leurs brigandages, à la première plainte qui nous en sera faite par l'empereur de France, les vice-rois et gouverneurs des pays de l'obéissance desquels seront les voleurs et corsaires seront tenus des dommages et pertes qu'auront faits les Français, et seront privés de leurs charges.... Si les corsaires d'Algers et Tunis n'observent ce qui est porté par cette capitulation, que l'empereur de France leur fasse courir sus, les chastie... nous approuvons.... Se trouvant par notre empire des esclaves français, étant connus pour tels des embassadeurs et consuls [2], ceux au pouvoir desquels ils se trouveront faisant refus de les délivrer, qu'ils soient obligés de les amener ou envoyer à notre Porte, afin d'être jugés à qui il appartiendra... Déclarons ceux qui contreviendront à ce notre vouloir, rebelles, etc." [3]

Cette situation changea notablement après l'assassinat du roi de France, car un enfant placé sur le trône, au milieu des factions italiennes et françaises qui se disputaient le pouvoir, n'avait rien de redoutable aux yeux des Turcs.

III

Le capitaine Foulques (ou Foucques, ou Fouque), de La Rochelle, commandait un navire à destination de l'Acadie, dans la société du sieur de Monts, en 1604; il comman-

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[1] Lescarbot dit que c'était vers les Casquets, un peu à l'ouest de Dieppe. Ne pas confondre cette localité avec le Conquet, petite ville de la basse Bretagne, pays des Cornouailles, que Champlain mentionne à la page 349 de ses Œuvres.

[2] Un frère de Poutrincourt vivait en Turquie et s'était fait musulman.

[3] *Archives curieuses de l'Histoire de France*, série 1, t. XV, pp. 411, 414, 419 et 421.

dait aussi le *Jonas*, qui partit de La Rochelle, en 1606, avec la colonie de Poutrincourt. C'est lui sans doute qui nous a laissé le rapport suivant, daté de 1612 :

" Memoires portants plvsievrs advertissems presentez av Roy par le Capitaine Foucques, Capitaine ordinaire de sa Maiesté en la marine du Ponant, apres estre deliuré de la captiuité des Turcs, pour le soulagement des François, et autres nations Chrestiennes, marchands et matelots qui trafiquent sur mer.

" Sire : — Il me serait mal seant, suyvant mon petit jugement, si je n'avoi adverty Vostre Majesté des tyrannies et cruautez qui se commettent journellement sur vos pauvres subjects françois, Dieu m'ayant de sa grace retiré de cette mesme peine afin de vous en donner advertissement, pour en prendre la vengeance, ayant la force et la puissance en la main, que Dieu vous a donnée pour ce faire contre tous payens et infidelles, lesquels pensent aller librement à leur trafiques et navigations ordinaires, sur l'assurance de la continuation de la paix accoutumée entre Vostre Majesté et le Grand-Sultan, qui néanmoins ne laisse à présent, et tous autres de la nation chrestienne et voyager, d'estre pris et menez captifs dans la ville des Thunes (Tunis), par le Carossemen ou ses adhérans, qui est un homme turc de nation, aagé de cinquante-cinq ans ou environ, homme bazanné, fort Grand et puissant à l'advenant, qui estoit soldat pour le grand Sultan sous le baschat (pacha) que le dit Sultan tient ordinairement au royaume de Thunes ; et ce dit Carossemen estant natif de la dite ville de Thunes, estant soldat genissaire, est si bien parvenu depuis quinze ans qu'il a assujetty tous les grands de Thunes sous son obéyssance, pour avoir acquis l'amitié de tous les genissaires et baschats. Et il n'y a que douze ans qu'il n'avoit que deux esclaves dont l'un est François de Croisy, lequel il tient encore en son pouvoir, et à présent a sept cens esclaves à luy seul, tant Italiens que François, Espagnols et Flamans ; et a deux galères bien armées, des meilleures qui se peut voir, avec six grands vaisseauz, dont le moindre est de trois cens tonneaux, et deux patasches, par le moyen de quoy il s'est rendu seigneur et supérieur dans tout le pays.... Ses vaisseaux prennent sur tous, tant François que Flamans et autres, soit terreneviers ou pescheurs venant de la Terre-Neufve, ou navires marchans, sans exempter aucune nation. Il y a trois ans [1] qu'il n'y avait rien de cecy ; en toute la force de Thunes il n'y avait que deux galliotes ou trois au plus ; ils ne prenaient point sur les François comme ils le font à présent. S'ils prenaient quelque chose, ils ne captivaient point les hommes, si ce n'est que, depuis les dits trois ans, un meschant forban anglais, nommé Gardes, et un autre Flamen, ou forban ou vouloir, qui est marié à Marseille, nommé de Haüs, lequel s'est retiré à présent dans la ville d'Arges (Alger), ne captivant nuls François, mais prenant et pillant leurs marchandises. Et est dans un navire à luy de six cens tonneaux et quarante pièces de canon, avec trois cens hommes, et deux autres moyens navires prenant sur toutes nations ; et un appelé Biche, un appelé Sanson, un appelé Antoine et un nommé Glandfil, tous capitaines voleurs et forbans, anglois de nation, lesquels ont esté bien venus avec Carossemen et ses associés turcs. Lesquel Anglois ont instruit les Turcs à armer et mettre vaisseaux sur mer, prendre et captiver sur toutes nations chrétiennes.... Et avec toute ceste force destruiront la chrestienté, si on n'y met remède, et la France qui en patira le plus, comme n'ayant eu jusques à présent aucune deffence en la coste.... Quant au roy de France, il (le Carossemen) dit qu'il est plus fort que luy, et

[1] C'est-à-dire avant la mort d'Henri IV.

qu'il ne sçauroit avoir mis deux gallères en mer, et qu'avec les siennes il ira jusque dans les ports de France.... Le consul des François qui est à Thunes est l'un des traistres ; il a de chacun François qui est là captif dix escus pour consentir et dissimuler avec le Carossemen.... Il est marié à Marseille, et s'apelle Hugues Changet.... Il y a aussi un appelé Soubéran, qui est natif de Nîmes, avec ses consors, qui sont un appelé Anthoine Lovic, Corse, marié à Marseille, et ses deux beau-frères, les Martins de la dite ville, et Antoine Belanger et Servien, commissaires de l'artillerie de Provence, et monsieur Nicolas, maistre fondeur de Marseille ; ceux-cy ont mené un nommé Guillaume, fondeur de son estat et nepveu de ce maistre fondeur du dit Marseille, qui est fondeur du Carossemen à Thunes, pour faire des canons.... A la fin de juillet dernier, ils avaient achevé de fondre la quatriesme pièce de batterie et coursiers de gallères...." [1]

IV

On le voit, la situation n'était guère rassurante. Pour les colonies de la Nouvelle-France elle se compliqua de l'hostilité des armateurs anglais. Samuel Argall détruisit en 1613, [2] les postes de Saint-Sauveur et de Port-Royal, les seuls établissements français de l'Acadie. C'était un acte de brigandage, commis en pleine paix et sans l'excuse d'une provocation. Voilà bien les mœurs du temps.

De nombreux vaisseaux de toutes les nations sillonnaient le golfe, à la recherche de la morue et autres produits de la pêche. Chacun s'en tirait avec peine et misère, et les aggressions allaient leur train. J'ai raconté, il y a deux ans, l'existence de Biencourt et de ses gens en Acadie, après 1615. Deux compagnies françaises commençèrent (1619) à exploiter les côtes de la peninsule. On dit que, en 1621, il circula dans le golfe huit cents navires de traite et de pêche. Les Anglais s'établissaient en 1620 au Massachusetts. Biencourt et Latour érigeaient des forts. Sir William Alexander tentait de créer une colonie écossaise sur les ruines de celle de Poutrincourt.

Tout cela ne se faisait pas sans amener des conflits, et, comme le désir de s'emparer des meilleurs endroits de ce nouveau monde grandissait à Londres et à Paris, le recours à la force brutale suivait le développement des ambitions mises en jeu pour y parvenir. Biencourt, Latour et Champlain, qui visaient plus haut que le simple commerce, ne recueillaient presque aucun avantage ; ils étaient même exposés à beaucoup de contretemps et de tracas par suite de ces animosités. On les voit s'en plaindre fréquemment. La lettre admirable de Biencourt [3] (1618) nous en fournit une preuve assez tangible. Paris, qui s'approvisionnait de poisson dans notre golfe, se voyant menacé d'en manquer par suite des périls que couraient les navires français dans ces parages où les haines nationales s'exerçaient ouvertement, tandis que la France était en proie aux guerres civiles et religieuses.

La lutte du parlement et des princes contre Marie de Médicis, le soulèvement des

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[1] *Archives curieuses de l'Histoire de France*, série 1, t. XV, p. 363.

[2] Les princes français étaient en pleine révolte contre le jeune Louis XIII et son ministre Concini. L'influence française devenait nulle en Europe.

[3] Mon ami Alfred Garneau dit qu'il attribuerait cette lettre à Marc Lescarbot, si elle ne portait une autre signature. En effet, c'est le style de Lescarbot. Je crois qu'il l'a écrite, et que Biencourt l'a signée, car il n'y a pas d'apparence que ce dernier fût un écrivain.

huguenots de Guienne et du Languedoc (1615), l'arrestation du prince de Condé, vice-roi de la Nouvelle-France (1616), l'envoi de trois armées royales contre le parti des princes, l'assassinat de Concini (1617), la révolte du Béarn, les débuts de la guerre de Trente ans en Europe (1618), la guerre entre Louis XIII et sa mère (1619), la réunion de la Navarre à la France (1620), la prise d'armes des calvinistes du royaume (1621), la guerre de la Valteline (1623), la guerre contre Gênes, une autre insurrection des protestants français (1625), — il n'en fallait pas davantage pour empêcher Louis XIII de s'occuper du Canada, si toutefois il en avait eu le désir

Richelieu, entré au Conseil (1624), était mal vu du roi, et d'ailleurs ce ministre était trop occupé des affaires du dedans pour songer à celles du dehors.

Depuis 1605, Jacques I, fils de Marie Stuart, régnait paisiblement sur l'Angleterre d'où il avait chassé les jésuites après la célèbre "conspiration des poudres." Ses sujets profitaient de la tranquillité publique pour créer des colonies sur le littoral de l'Atlantique, et supplanter les Français dans le golfe Saint-Laurent, où ils venaient pêcher en eau trouble, — c'est le cas de le dire, puisque la France ne protégeait plus ses nationaux dans ces parages. Au moment où Richelieu pesa décidément dans la destinée de son pays, et parla tout haut de surveiller les affaires de l'Amérique, le roi d'Angleterre maria son fils aîné, Charles I, avec Henriette, fille d'Henri IV, et mourut aussitôt (1625), laissant le trône à ce fils désormais allié de la France, croyait-on.

V

Le frère Gabriel Sagard, se rendant au Canada, dans l'été de 1623, nous fournit une peinture assez vive de ce qui se passait sur l'Océan à cette époque. Citons quelques lignes de sa description :

"On se plaint avec raison du grand nombre de voleurs et de larronneaux, qui en guise de chenilles couvrent aujourd'hui presque toute la surface de la terre, dont les uns semblent honnêtes gens et passent pour de gros messieurs, et ceux-là sont les pires de tous, car ils dérobent beaucoup et font pendre ceux qui prennent le moins. Les autres, moins dangereux, sont ceux qui comme hiboux ne vont que de nuit, sont assez mal couverts et aussi peu courtois.... De ces pirates vous en voyez qui font les honnêtes marchands pour n'être point soupçonnés, et surprendre quand ils trouvent leur coup disposé... et ce fut un de ceux-là qui nous vint menacer à deux ou trois cents lieues en mer... mais il nous laissa aller, ayant bien opinion qu'allant en Canada on n'avait pas grand richesse.... Nous rencontrâmes un petit navire anglais.... Il pouvait s'esquiver, mais comme nous étions assez bons voiliers, nous allâmes à lui et lui demandâmes, selon la coutume de la mer usitée par ceux qui se croyent les plus forts : "D'où est le navire ?" — Il répondit : "Angleterre." — On lui répliqua : "Amenez !" c'est à dire abaissez vos voiles, sortez votre chaloupe et venez nous faire voir votre congé.... En cela il se commet souvent de très grands abus, pour ce que tel feint d'être marchand, et avoir bonne commission, qui lui-même est pirate et marchand tout ensemble, se servant des deux qualités selon les occasions et rencontres. De même nos mariniers eussent bien désiré la rencontre de quelque petit navire espagnol, où il se trouve ordinairement de riches marchandises, pour en faire curée et contenter aucunement leur convoitise, comme si prendre le bien d'autrui sur mer n'était pas larçin et volerie obligeant à la damnation éternelle, aussi bien que le prendre sur terre.... Nos

Anglais vinrent à nous, savoir : leur maître, un vieil gentilhomme... ils appréhendaient le même traitement qu'ils sont accoutumés de faire aux Français, quand ils ont le dessus, c'est pourquoi leur chef offrit en particulier à notre capitaine tout ce qu'ils avaient en marchandises en leur navire, pourvu que la vie sauve on les laissât aller en leur pays avec un peu de vivres, ce que notre capitaine refusa.... Néanmoins il nous fit accepter un baril de petun et un autre de patates : ce sont certaines racines des Indes, en forme de gros naveaux, rouges et jaunes, mais d'un goût beaucoup plus excellent que toute autre racine que nous ayons par deça."

Si l'on veut savoir comment se gouvernaient les affaires du golfe et du fleuve Saint-Laurent, de 1621 à 1625, lisons les mémoires de Champlain, dont voici quelques extraits :

En 1621, le roi et le duc de Montmorency adressèrent des lettres au fondateur de Québec pour lui recommander de faire bon accueil à la nouvelle compagnie dirigée par les sieurs de Caen, sur quoi Champlain fit l'observation suivante : " Pendant qu'une société, en un pays comme celui-ci, tient la bourse, elle paye, donne et assiste qui bon lui semble. Ceux qui commandent pour Sa Majesté sont fort peu obéis, n'ayant personne pour les assister que sous le bon plaisir de la compagnie, qui n'a rien tant à contre cœur."

Le 23 juillet 1623, Champlain écrivait de Québec :

" Ce jour même arriva le pilote Doublet, lui sixième, dans une double chaloupe qui venait de l'île Saint-Jean et Miscou, où était le sieur de la Ralde en pêcherie, qui donnait avis au sieur de Caen que des Basques s'étaient retirés à la dite île Saint-Jean pour se mettre en défense si on les allait attaquer, ne voulant subir aux commissions de Sa Majesté, et qu'ils s'étaient saisis d'un moyen vaisseau où était un nommé Guers (ou plutôt Guérard), qui l'année d'auparavant était venu à Tadoussac.... Ces Basques avaient donné de mauvaises impressions de nous aux sauvages des côtes. Le premier du mois de juin,[1] arriva à Québec un canot de Tadoussac qui nous dit qu'aux environs du Bicq il y avait un vaisseau rochelois qui traitait avec les sauvages, que dans ce vaisseau était un puissant homme qui y commandait, étant toujours masqué et armé.... L'on empêche les autres vaisseaux de venir traiter avec les sauvages." Ceux-ci, ajoute-t-il, se procuraient des marchandises à meilleur marché des Rochelois et des Basques que de la Compagnie du Canada. Ce même printemps, l'un des vaisseaux des sieurs de Caen fut pris par les Hollandais ou Flamands. Le 19 septembre 1624, Champlain retournant en France, aperçut dans le golfe Saint-Laurent un navire de La Rochelle et lui donna la chasse, mais sans pouvoir l'atteindre. Le frère Sagard, qui était du voyage, dit que ce navire était " un pirate rochelois qui nous était " venu reconnaître." Il ajoute que les équipages de Champlain parlaient avant ce moment d'attaquer onze bâtiments basques, vers Miscou, et d'aller ensuite s'emparer des vaisseaux espagnols aux îles Açores. " Dieu sait quelle prouesse nous en eussions faite, dit-il, n'ayant " pu prendre un forban de soixante tonneaux ! " Le 27 septembre, sur les bancs de Terre-Neuve, une petite barque où commandait Cananée se sépara de Champlain, pour aller à Bordeaux, selon l'ordre qu'il en avait. Depuis, nous sûmes qu'elle fut prise des Turcs, le long de la côte de Bretagne, qui amenèrent les hommes qu'ils y trouvèrent et les firent esclaves."

Dans la commission que le duc de Vendatour accorde à Champlain, le 15 février 1625,

[1] Vers cette date, le capitaine Charles Daniel, qui commandait un navire de Dieppe en destination du Canada, soutint sans désavantage un rude combat contre des bâtiments anglais. (Julien Félix : " *Voyage du capitaine Charles Daniel.*")

il autorise celui-ci à saisir hommes, vaisseaux et marchandises, de provenance française qu'il trouvera trafiquant notamment depuis Gaspé jusqu'au cinquante-deuxième degré nord, et à les livrer à la justice. Champlain ajoute : " Il y a un lieu dans le golfe Saint-Laurent qu'on nomme la Grande-Baie, proche du passage du nord de l'île de Terre-Neuve, à cinquante-deux degrés, où les Basques vont faire la pêche des baleines."

Dans l'été de 1626, Champlain étant à Québec raconte que le sieur de la Ralde lui envoya des nouvelles de Miscou, [1] portant qu'il avait trouvé plusieurs vaisseaux qui traitaient avec les sauvages, contre les défenses du roi, et demandant des secours armés pour en opérer la capture [2].

Ainsi marchait l'établissement du Canada, c'est-à-dire que rien de durable ne se faisait. Champlain en avait un chagrin continuel. La morue, le hareng, le castor, l'orignal, — il paraissait impossible de sortir de là. Le projet de cultiver les terres se mettait sur le papier, et y restait. Tout ce qui ne rapportait point de bénéfice immédiat pouvait être approuvé, mais non exécuté. L'heure allait venir néanmoins où une politique moins aveugle serait invoquée par les hommes d'Etat.

VI

Fouillez les archives de France et les livres imprimés, vous ne trouverez pas deux auteurs de la force de Lescarbot et Champlain sur l'idée coloniale, à venir jusqu'au moment où Richelieu prit la direction des affaires. Cela ne veut pas dire qu'il n'y eût en France, avant 1625, des hommes éclairés et tout à fait bien disposés en faveur de ce mouvement ; certes, nous n'aurions qu'à citer le président Jeannin et son groupe pour affirmer d'honorables exceptions ; mais pris comme ensemble, le monde administratif français était très en arrière des Espagnols sous ce rapport.

Dans la *Revue de géographie* de Paris, 1885, M. Léon Deschamps a publié une étude dont j'emprunte ici des passages, sous forme de citations ou d'analyses. Il dit :

" Avec cette promptitude de jugement et de pessimisme à notre égard qui nous sont particuliers, les contemporains de Champlain et Lescarbot — quelques-uns du moins — ont préféré l'aventure de Villegagnon à l'expédition de Champlain ou de beaucoup d'autres, pour asseoir leur jugement. Mais il s'est trouvé heureusement des patriotes éclairés, comme Rasilly, pour faire voir que ce sont vieilles chimères." Rasilly, ajoute-t-il, écrivait en 1626 : " Plusieurs personnes de qualité et même du Conseil m'ont dit et soutenu que la navigation n'était point nécessaire en France, d'autant que les habitants d'icelle ne voyant toutes choses que pour vivre et s'habiller, sans rien emprunter des voisins : partant, que c'était pure erreur de s'arrêter à faire naviguer — et que l'exemple est que l'on a toujours méprisé au passé les affaires de la mer comme étant de tout inutiles : et outre que les Français ne sont pas capables d'entreprendre de voyages de long cours, ni planter colonies. A quoi je réponds que ce sont vieilles chimères de croire que la navigation ne soit pas nécessaire en France, et que les Français ne soient propres à naviguer, et je prétends faire voir le contraire.... J'ai le cœur tout serré quand je viens à considérer les dis-

[1] En 1627, il y avait parmi les Cent-Associés un nommé Guillaume Martin, et c'est son fils, je crois, qui acheta, vers 1680, le titre de marquis de Miscou (voir le *Magasin Pittoresque*, année 1849, p. 247).

[2] *Œuvres de Champlain*, pp. 996-7, 1045-6, 1059, 1061, 1075, 1088 et 1113.

cours que font tous les jours les étrangers quand ils parlent de la France, et même j'ai eu dispute pour soutenir l'honneur du royaume."

Le 10 septembre 1626, Richelieu écrivait à Rasilly : " Quand votre frère Launay Rasilly sera ici, nous parlerons particulièrement ensemble " du projet des colonies.

Jean de Lauzon adressait au cardinal, le 26 novembre 1626, une lettre dans laquelle, s'exprimant au nom des négociants de Rouen, il dit que ces derniers remercient le roi de l'intérêt qu'il porte au commerce et du souci qu'il a de le protéger contre les corsaires, mais ils lui remontrent qu'il n'a pas pris, à leur avis, la meilleure voie pour aller au but. D'abord l'achat de navires aux Hollandais n'aurait pas dû être fait au nom du roi, à cause " de l'appréhension qu'ils ont (les Hollandais) que le roi ne devienne puissant sur la mer." Et ils ajoutent que, si l'on avait emprunté le nom des négociants, le roi serait servi avec plus de diligence. Ce n'est pas assez ; il faut que le roi fasse construire les vaisseaux en France, " non pas en si grand nombre à la fois, mais tant il y a qu'il pourrait être servi avec contentement." Une partie de ces vaisseaux pourraient être employés " à l'assistance des navires marchands," à la condition qu'on donne aux négociants la liberté entière d'y préposer " telles personnes de probité et valeur reconnues qu'ils pourront choisir eux-mêmes. Ils fourniraient des vaisseaux, les tiendraient en état de servir le roi. Quant à la dépense, ils proposaient une répartition à prendre sur les marchandises convoyées." A aucun prix ils ne veulent de capitaines nommés par le roi. Les continuelles pertes souffertes durant les dernières années font que les négociants refusent de contribuer à la construction des navires ici mentionnés, mais ils indiquent un moyen d'y pourvoir : c'est de faire comme le roi d'Angleterre qui " l'an passé fit par forme d'emprunt de grandes levées sur les étrangers de nouveau établis en son royaume jusqu'à faire payer vingt mille écus à tel d'entre eux." On est, disent-ils, d'une tolérance inouïe pour les étrangers qui habitent la France ; on leur accorde des lettres de naturalisation, sans même exiger qu'ils possèdent ou contribuent en ce pays. " Ils n'y font aucunes acquisitions d'immeubles, n'y font construire aucuns vaisseaux, et ayant tous leurs biens en une cassette le transportent quand il leur plaît." [1] Bien plus, on leur donne les mêmes droits et faveurs qu'aux Français, tandis que les autres nations se réservent chez elles certains privilèges, comme en Angleterre, par exemple, où les Anglais ne paient que moitié des droits imposés aux Français qui les fréquentent.

VII

Les grandes compagnies datent de ce moment, c'est-à-dire de 1626.

Après avoir cité les textes ci-dessus, M. Léon Deschamps continue : " Il est important de savoir d'où est venue l'idée des grandes compagnies dont le monopole et les privilèges ont tant nui au succès de nos établissements. Richelieu a exposé toute sa politique coloniale devant l'assemblée des notables en 1626, et ses mémoires donnent l'analyse de son discours : " Il n'y a de royaume si bien situé que la France et si riche de tous les moyens nécessaires pour se rendre maître de la mer. Pour y parvenir, il faut voir comme nos voisins s'y gouvernent, et il faut faire de grandes compagnies, obliger les marchands

[1] La plupart de ces citations conviennent encore à l'état des choses en France, deux siècles et demi après Richelieu.

d'y entrer, leur donner de grands privilèges comme ils font ; faute de ces compagnies, et parce que chaque petit marchand trafique à part, et partant pour la plupart en de petits vaisseaux et assez mal équipés, ils sont la proie des corsaires et des princes non alliés, parce qu'ils n'ont pas les reins assez forts comme aurait une grande compagnie, de poursuivre leur justice jusqu'au bout. Ces compagnies seules ne se voient pas néanmoins suffisantes si le roi de son côté n'est armé d'un bon nombre de vaisseaux pour les maintenir puissamment au cas qu'on s'opposât par force ouverte à leurs dessins. Outre que le roi en tirerait cet avantage qu'en un besoin de guerre il ne lui soit pas nécessaire d'avoir recours à mendier l'assistance de ses voisins."

Cette année, 1626, le cardinal-ministre achetait des Hollandais vingt navires et avait obtenu, non sans supplications, qu'on les lui cédât avec la permission de les faire monter et commander par des Français.

M. Deschamps expliqua encore ce fait : " Richelieu a été amené, par l'invitation des Espagnols, des Anglais et surtout des Hollandais, à choisir le système des compagnies privilégiées comme mode unique de fondation et d'exploitation des colonies, et ce système a pesé depuis lors et jusqu'à la Révolution sur notre histoire coloniale." Il veut toutefois que l'on rende hommage au génie du cardinal : " C'est Richelieu qui a réellement inauguré la politique coloniale, en lui donnant une place et un rôle dans le jeu de sa politique continentale. Après lui, malgré la pauvre administration de Mazarin, qui laisse nos vaisseaux pourrir au port, malgré la Fronde et malgré les déprédations financières la tradition fut suivie. Les actes et mémoires du gouvernement et des particuliers ne sont pas moins nombreux de 1642 à 1660 que dans la période précédente."

En 1626, dans son Mémoire au roi, Richelieu demande de relever la puissance maritime de sa patrie, sans laquelle, dit-il, il ne fallait plus faire état d'aucun trafic. Se voyant en faveur, il annonce qu'il est résolu à consacrer un million et demi de francs par année à l'entretien de trente vaisseaux de guerre pour tenir les côtes nettes. Il songeait à créer une nouvelle France — même plusieurs Frances en Amérique. Il lui semblait que l'Europe devait agir comme tête du mouvement universel — donner l'impulsion et garder la suprême puissance sur des colonies qui seraient le dédoublement des nations du vieux monde — et il voulait que la France eût sa part de ces entreprises à la fois glorieuses et profitables. M. Deschamps l'en félicite : " La marine et les colonies ont été des constantes et principales occupations de Richelieu. Dès le début de son ministère, il s'est fait donner la charge de grand-maître, chef et surintendant général de la navigation et commerce du Canada. Son brevet de grand-maître est du mois d'octobre 1626, mais déjà, en 1625, il adressait à Louis XIII un " Règlement pour la mer " et un " Mémoire " qui contenaient des idées novatrices.... Il mérite la première place, moins parce qu'il est le premier en date, que parce qu'il est le véritable initiateur de la politique coloniale ; Colbert en a seul la gloire devant la postérité. Il serait injuste de contester à Colbert son mérite, mais il est certain qu'il n'a été que l'élève de Richelieu. Il a fait analyser et classer toutes les pièces du cabinet de son devancier, les a étudiées et s'en est servi. L'examen des documents gardés aux archives des affaires étrangères ne laisse aucun doute à cet égard."

C'était donc un nouveau courant d'idée qui traversait la France en 1625-26. Richelieu a eu la gloire de le comprendre et d'utiliser sa force. S'il n'a pas réussi tout à fait, imputons-en la faute à cette politique de conquête ou de domination européenne dont il fut saisi peu d'années après 1626, tout comme Louis XIV en 1673, au moment où il venait,

avec l'aide de Colbert, de préparer les plans les plus beaux et les plus exécutables en faveur du Canada. Dès que l'ambition d'un grand ministre ou d'un grand roi se repliait sur la seule Europe, il rétrécissait son rôle sans le savoir, et renvoyait à la postérité ou à un autre peuple que le sien, la noble tâche de dominer le monde entier par l'expansion coloniale.

III — *Un Pèlerinage au pays d'Evangeline,*

Par L'ABBÉ CASGRAIN.

(Lu le 27 mai 1886.)

A mon ami A. DUCLOS-DECELLES,
Bibliothécaire du Parlement, à Ottawa.

MON CHER AMI, — " J'apprends, m'écrivez-vous, que vous êtes de retour d'un voyage dans les provinces maritimes, et que vous étiez à Grand-Pré juste au jour anniversaire de l'expulsion des pauvres Acadiens. Que n'étais-je auprès de vous pour partager les émotions que vous avez dû ressentir en visitant le site du village, du cimetière et de l'église, d'où les infortunés Acadiens furent forcés, l'épée dans les reins, de prendre le chemin de l'exil! Faites-moi donc du moins part de quelques-unes de vos impressions, de ce que vous avez vu, observé, de ce qui vous a le mieux redit le passé de l'Acadie. Que reste-il des ruines de l'ancien Port-Royal, des forts Beauséjour, Beaubassin, etc.? Tout ce que vous m'apprendrez aura pour moi de l'intérêt."

Mon cher ami, vous m'écrivez comme si je revenais de l'Acadie les mains pleines de dépouilles archéologiques. Détrompez-vous, je n'ai fait qu'une excursion de touriste, et n'ai guère rapporté que des impressions et des notes de voyage. Mais, puisque vous le désirez, les voici: je les transcris de mon carnet, et vous les envoie telles que je les ai prises au vol de la pensée, un peu comme ces gibiers que je voyais abattre par les chasseurs dans les joncs de la rivière Gaspareaux.

La seule étude qui mérite votre attention dans ce *journal* de voyage est le récit de la dispersion des Acadiens, d'après des documents dont les uns sont nouveaux, les autres peu connus.

I

Départ de Québec à huit heures du matin, le 1er octobre. — Je ne sais plus quel auteur a dit: " Je ne connais pas de plaisir plus triste que celui des voyages." Rien de plus vrai, si le voyageur n'a pas un but arrêté. Il a beau changer de scène, chevaucher, comme on disait au temps de Boileau, " *l'ennui* monte en croupe et galope avec lui." Aussi ai-je bien eu le soin de donner un sens à l'excursion que j'entreprends. J'irai voir Grand-Pré, le pays d'Evangeline, et les colonies acadiennes qui fleurissent aujourd'hui heureuses et grandissantes, comme avant la dispersion, non loin du bassin des Mines, sur les bords du Peticoudiac et du Memramcook.

Le train express de l'Intercolonial longe à toute vitesse les falaises de Lévis, et découvre les divers points de vue du port de Québec; l'île d'Orléans, avec ses coquettes maisons

échelonnées sur ses hauteurs, ombrées çà et là de massifs d'arbres ; la nappe de neige du saut Montmorency, les prairies de Beauport, et au-dessus de tout le paysage, le cap crénelé de la vieille forteresse, avec sa ceinture de maisons, et sa forêt de mâts à ses pieds. Tout familiers que sont les Québecquois avec leur paysage, ils ne s'en lassent jamais ; ils permettent volontiers aux touristes de l'admirer en passant, mais ils se réservent de l'admirer toujours.

Arrivé à Campbellton à 7 heures du soir. — Campbellton, village anglais, à 305 milles de Québec, et situé au fond de la baie des Chaleurs, sur la rivière Ristigouche, qui sert ici de frontière entre la province de Québec et celle du Nouveau-Brunswick. De l'autre côté de la rivière, s'élève le village sauvage de Sainte-Anne de Ristigouche, sur un étroit plateau resserré entre l'eau et les montagnes.

Je m'arrête ici quelques jours afin de voir de près ces bonnes familles micmaques, dont le souvenir se mêle à mes premières impressions d'enfance. Il me semble encore voir passer leurs longues files de canots d'écorce au bord de la grève. Leurs petites flottilles de quinze ou vingt pirogues ne doublaient pas la pointe de la Rivière-Ouelle sans s'y arrêter, car, comme je l'ai déjà dit ailleurs, les sauvages ont toujours affectionné ce promontoire couvert de bois, où ils avaient abondance de chasse et de pêche. Ils traînaient leurs embarcations sur le sable du rivage, et y dressaient leurs cabanes pour quelques jours. La fumée de leurs feux, que nous apercevions au-dessus des arbres, nous avertissait de leur présence. Ils ne tardaient pas à descendre au manoir, attirés surtout par les présents que leur faisait ma mère, qui avait pour eux des prévenances de toutes sortes, car elle a toujours eu pour ces pauvres sauvages une affection qu'elle ne négligeait en aucune occasion de nous communiquer.

J'ai encore présentes à l'esprit quelques-unes de ces figures caractéristiques et étranges pour nous, avec leurs traits osseux et basanés, leurs yeux perçants et leurs longs cheveux noirs et plats. Leur accoutrement n'était pas moins étrange que leur personne. Ils étaient le plus souvent tête nue ; la *couverte* de laine dont ils s'enveloppaient leur descendait jusque au-dessous des genoux, et leurs pieds étaient chaussés de mocassins. Les femmes portaient sur leurs épaules des charges d'ustensiles en écorce et de paniers de toutes grandeurs et de toutes nuances. En retour des présents qu'elles recevaient, elles donnaient aux enfants quelques-uns de ces petits paniers, qui nous servaient de jouets entre nos heures d'école.

Un matin, on voyait la flottille, dont chaque canot était chargé de cinq ou six sauvages, prendre le large et pagayer vers la pointe des Aulnaies, pour de là remonter jusqu'à Québec, où ils recevaient leur *prêt* du gouvernement, qui consistait en fusils, munitions, *couvertes*, etc., etc. Mais un autre motif les engageait à entreprendre ce long et pénible voyage ; ils venaient satisfaire leur dévotion envers la " bonne sainte Anne du Nord," pour laquelle, de temps immémorial, ils ont eu un culte touchant, et qui a souvent été récompensé par d'éclatants miracles. La plupart faisaient coïncider leur pèlerinage avec la date des distributions annuelles ; mais en d'autres temps, même aux époques rigoureuses de l'année, on voyait passer des familles entières, des malades se traîner péniblement, mendier l'hospitalité le long de la route, dans l'unique but d'aller implorer la sainte patronne dans son sanctuaire privilégié.

Un soir — c'était la veille de Noël — pendant que ma mère était occupée au salon à faire une lecture aux aînés de ses enfants, afin de les préparer à la fête du lendemain,

une de nos domestiques vint lui annoncer que deux *sauvagesses* venaient d'entrer et demandaient à lui parler. Attirés par la curiosité, nous accourûmes à sa suite.

Les deux *sauvagesses*, la mère et la fille, étaient assises auprès du poêle, dans la cuisine. La jeune fille, maigre, pâle comme une morte, avait l'air presque mourante. Une toux creuse, qui lui déchirait la poitrine, indiquait clairement qu'elle était à un période avancé de la consomption. Les deux pèlerines venaient demander l'hospitalité afin d'être proches de l'église et d'assister à la messe de minuit, où elles voulaient communier. Ma mère leur fit immédiatement préparer à souper, et les invita à s'approcher ; mais ni l'une ni l'autre ne consentirent à prendre une seule bouchée, disant qu'elles ne voulaient pas se priver de faire la communion. Ma mère eut beau leur expliquer que, la communion n'ayant lieu qu'après minuit, il était permis de prendre quelque chose auparavant, que le prêtre qui célébrait la messe faisait de même, elles s'y refusèrent obstinément. Aveugle mais touchante foi de ces bonnes gens, qui fait bien voir la fermeté de leur croyance, et le grand respect qu'elles avaient pour l'eucharistie.

Ces pèlerinages ont cessé peu à peu depuis l'érection de l'église actuelle de Ristigouche, qui a été dédiée à sainte Anne. Cette église, dont l'intérieur a été achevé il y a une vingtaine d'années, est sans prétentions architecturales, mais propre et convenable. Il n'en est pas de même du presbytère, qui a été mal construit et qui est devenu inhabitable, surtout en hiver. Comme il n'y a dans le voisinage aucune maison où le prêtre puisse se retirer, et qu'il n'y a aucunes ressources pour bâtir un nouveau presbytère, les pauvres sauvages sont exposés à être privés un jour où l'autre de leur curé, et à n'être desservis que par voie de mission. Cet éloignement leur serait fatal, car aucune population n'a plus besoin de l'œil vigilant du pasteur. Espérons que la bonne sainte Anne, pour laquelle ils ont toujours la même dévotion, viendra à point à leur secours, comme elle a fait tant de fois dans le passé.

Les maisonnettes du village, lesquelles sont bâties et meublées à peu près comme celles de nos cultivateurs pauvres, sont échelonnées tout le long de la *réserve*, qui n'a guère que trois milles d'étendue. Quelques-unes sont assez spacieuses et ont un certain air de propreté et de confort.

Le costume de ces Micmacs n'a guère d'original que l'espèce de turban que portent les femmes, qui consiste en un grand foulard rouge qu'elles enroulent autour de leur tête. A peine y en a-t-il quelques-uns parmi cette tribu qui aient le vrai type sauvage. Leurs traits et les noms de famille de plusieurs d'entre eux rappellent le sang européen dont ils sont plus ou moins mêlés. Comme partout ailleurs, ils sont plus aptes à s'approprier les vices que les vertus des blancs. Insouciants et sans prévoyance comme au temps jadis, ils ne s'adonnent guère à la culture, n'ensemencent que quelques petits champs de pommes de terre et de grains. La pêche et la chasse sont encore leurs occupations favorites, et ils n'ont rien perdu de leur habileté à construire et à guider leurs admirables canots d'écorce, vrais chefs-d'œuvre de légèreté, d'élégance et de solidité. Les bêtes à fourrures deviennent de plus en plus rares dans cette région ; mais les caribous, m'assurent quelques chasseurs, sont encore assez communs dans la presqu'île gaspésienne. Les meilleurs hommes parmi cette tribu micmaque trouvent une source de profits en servant de guides aux sportsmen anglais, américains, etc., qui viennent en été dans ces parages pour la pêche à la mouche, soit du saumon, soit de la truite. Ils sont doux et tranquilles, parlent peu et ont gardé quelque chose de cette timidité et de cette réserve naturelles à leur race. Les désordres

que cause parmi eux l'ivrognerie ont été réprimés depuis que leur missionnaire a fait nommer par le gouvernement fédéral un officier de police qui veille sévèrement à l'observation de la loi. Quiconque leur livre de la boisson est passible d'une très forte amende ou de la prison. Aucun blanc ne peut demeurer sur la *réserve* après le coucher ou avant le lever du soleil.

Dimanche, 4 octobre. — A la grand'messe, un chœur de sauvages et de *sauvagesses* chantent dans leur langue les principales parties de l'office divin. Leur voix, justement vantée, est d'une beauté rare, avec un timbre mélancolique qui pénètre et impressionne.

Les éloges qu'en ont faits les anciens voyageurs n'ont rien d'exagéré : " Je les ai plus d'une fois, racontait Dièreville en 1700, entendus chanter dans l'église de Port-Royal à la grand'messe et à vêpres ; les voix des femmes particulièrement étaient si douces et si touchantes que je croyais entendre les anges chanter les louanges de Dieu. Les voix des hommes se mêlaient de temps en temps si justement avec celles des femmes, que cela faisait un effet admirable, et j'en étais charmé." [1]

Invité à faire le sermon, j'admire l'éloquence et les gestes expressifs de l'interprète Polycarpe, qui, debout à la balustrade, me dévore des yeux pendant que je parle ; puis, après avoir écouté un passage de mon sermon, le traduit avec la plus étonnante fidélité, au dire de plusieurs des assistants qui comprennent les deux langues, et que j'ai pris la peine d'interroger ensuite. Polycarpe est depuis quelques années le chef de la tribu ; c'est un grand gaillard dans toute la force de l'âge, beau type de sang mêlé, d'un visage et d'un caractère avenants, influent parmi les blancs comme dans sa tribu.

La population micmaque de Ristigouche, dont le chiffre reste à peu près stationnaire, ne dépasse pas 500 âmes. Comme tous les autres groupes de race indigène, elle est destinée fatalement à disparaître ou à se noyer dans le flot populaire qui l'environne. A la fin du siècle prochain, il n'en restera probablement pas d'autre trace que les manuscrits en langue sauvage de l'abbé Maillard, surnommé l'apôtre des Micmacs, dont j'ai feuilleté les pages jaunies et rongées par le temps dans la bibliothèque de la mission. Ces manuscrits qu'on ne peut ouvrir sans éprouver un sentiment de respect et d'admiration, à la vue des patients travaux et du zèle apostolique qu'ils indiquent, ces glossaires dont les feuilles usées se détachent, sont bien les monuments qui conviennent le mieux pour rappeler le souvenir de ces tribus éphémères que le souffle de la civilisation emporte comme les feuilles de leurs forêts.

II

Lundi. — Matinée d'automne claire et fraîche. La température en septembre et octobre est plus douce dans la baie des Chaleurs que dans la vallée du Saint-Laurent.

La rivière Ristigouche coule entre des montagnes fortement accentuées et couvertes de forêts primitives. On n'aperçoit de champs cultivés que sur les plateaux qui bordent les rivages.

Les montagnes s'ouvrent en bleuissant au loin, de cap en cap, baignant leurs pieds dans les eaux de la baie des Chaleurs.

Sur l'avant-scène, au milieu de la rivière, se détache du ciel bleu la vigoureuse sil-

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[1] *Voyage de Dièreville en Acadie ;* édition imprimée à Québec, 1885, p. 101.

houette d'un navire norvégien chargé de bois de construction, qui appareille pour Belfast. Trois autres navires sont amarrés le long des quais. Il y a cent vingt-cinq ans, au mois de juillet 1760, le même nombre de vaisseaux étaient ancrés dans cette même rade ; mais c'était la guerre et non le commerce qui les avait poussés jusqu'ici. " Québec, raconte l'abbé Ferland dans son *Voyage dans la Gaspésie*, avait été pris l'automne précédent. Pressée par le marquis de Vaudreuil, la cour de Versailles envoyait de faibles et tardifs secours au chevalier de Lévis, qui était décidé à tenter une attaque contre Québec. La flottille française s'était amusée en route à poursuivre quelques navires ennemis ; aussi fut-elle devancée par les vaisseaux anglais, qui lui barrèrent le passage à l'entrée du fleuve Saint-Laurent. Elle se jeta alors dans la baie des Chaleurs, et remonta la rivière Ristigouche, où le commandant, M. de Danjac, trouva quinze cents personnes réfugiées sur ses bords, et vivant dans un état déplorable de misère. Le capitaine Byron, probablement le célèbre navigateur, grand-père du poète de ce nom, s'avança avec les vaisseaux le *Fame*, le *Dorsetshire*, l'*Achilles*, le *Scarborough* et le *Repulse*, pour attaquer la flotte française, qu'il rencontra le 8 juillet à peu près dans cette partie du Ristigouche. Elle était composée du *Machault*, de trente-deux canons, — de l'*Espérance*, de trente, — du *Bienfaisant*, de vingt-deux, — du *Marquis de Marloze*, de dix-huit. Les Français s'étaient préparés à recevoir chaudement l'ennemi ; leurs vaisseaux étaient protégés par la pointe à la Batterie, où plusieurs canons avaient été mis en position. Plus bas, à la pointe à la Garde, d'où la vue s'étend jusqu'à l'embouchure du Ristigouche, était un piquet de soldats, qui avaient ordre de veiller sur le cours de la rivière et d'avertir de l'approche de la flotte anglaise.

" Favorisés par un bon vent, les vaisseaux de Byron remontèrent sans obstacle jusqu'à la pointe à la Batterie, où une vive canonnade s'engagea. Deux bâtiments français furent mis hors de combat, et les canons de la batterie réduits au silence. Le *Bienfaisant* et le *Marquis de Marloze* durent alors se retirer vers le village sauvage, tandis que les Anglais s'avançaient jusqu'à la pointe à Martin, sur la rive opposée, où ils souffrirent beaucoup du feu de quelques canons placés à fleur d'eau. Cependant leur artillerie supérieure criblait les vaisseaux français. Un de ceux-ci fut poussé au rivage, près de la chapelle de Ristigouche, tandis que le commandant de l'autre mettait le feu aux poudres, afin de l'empêcher de tomber aux mains des Anglais.

" Resté maître du champ de bataille par la destruction de la flotte ennemie, Byron fit détruire un amas de cabanes décoré du nom de Nouvelle-Rochelle, et situé sur la pointe à Bourdo, à trois milles au-dessus du village de Ristigouche. Pendant ce temps les Français et les Micmacs se réfugiaient dans les bois, où ils attendaient en sûreté le départ de la flotte anglaise.

" L'imagination se reporte vivement vers ces scènes animées et terribles, quand on se trouve sur le théâtre même de la lutte. Les vaisseaux des deux nations rivales se croisant, se fuyant, se rapprochant ; leurs longs pavillons qui flottent dans les airs et portent un défi à l'ennemi ; au milieu des broussailles du rivage, ces troupes sauvages grotesquement coiffées et habillées ; ces caps arides surmontés du drapeau blanc et défendus par des pièces d'artillerie, dont la gueule s'allonge hors des meurtrières pour vomir le feu et la mort ; ces nuages de fumée roulant sur les eaux et dérobant aux combattants la vue du ciel ; les craquements des mâts qui se brisent, les sifflements aigus du commandement, le bruit de la mousqueterie et du canon, les cris de la victoire, de la douleur et de la rage : voilà les parties du drame qui se jouait, il y a soixante-quinze ans, sur le théâtre resserré,

au milieu duquel nous nous trouvons. C'était un des épisodes de la rivalité entre la France et l'Angleterre."

III

Mardi, 5 octobre. — De Campbellton à Memramcook, deux cent cinq milles. Une nuit en *sleeping car*. Avec tout leur esprit inventif, les Américains trouveront difficilement un moyen de locomotion plus commode et plus confortable que ces chars-dortoirs ; ce qui n'empêche pas qu'on en sorte toujours plus ou moins ahuri, poudreux, harassé. Il en est des nuits qu'on y passe comme des champignons, la meilleure ne vaut rien.

De la gare de Memramcook, on aperçoit à droite, sur une hauteur, à deux milles de distance, le beau portail gothique de l'église paroissiale, le collège de Saint-Joseph et le joli couvent des religieuses de la Charité. On a quitté le pays des montagnes. Un sol ondulé et fertile, qui me rappelle les plaines de la Vendée ou de la Touraine, s'étend de tous côtés à perte de vue. Je me sens le cœur réjoui en songeant que cette belle contrée arrosée par les rivières Memramcook et Peticoudiac est encore toute française. Les Acadiens, qui en avaient été expulsés en 1755, en ont de nouveau pris possession, et ils y ont si bien prospéré qu'ils forment aujourd'hui le groupe le plus important de leur race au Canada. La paroisse de Memramcook à elle seule ne compte pas moins de six mille âmes. Les terrains que leurs ancêtres avaient conquis sur la mer par les travaux d'endiguement qu'ils avaient faits le long des deux rivières, et qui avaient été submergés après la dispersion, ont été remis en culture dès leur retour. Ces terrains ont été tellement agrandis d'année en année, qu'aujourd'hui leur longueur totale n'a pas moins de trente milles sur une largeur considérable.

Le brave Acadien qui m'a fourni son rustique équipage pour me conduire au collège, me fait remarquer les *aboiteaux*[1] qui suivent les contours du Memramcook et qui ressemblent de loin à un immense serpent couché dans l'herbe.

Pendant que je passe devant le portail de l'église, j'admire ses élégantes proportions et la flèche hardie qui le surmonte. J'observe, sans pouvoir me l'expliquer, la ressemblance de cette pierre de taille avec celle qui a servi à la construction des rues fashionables de New-York.

Le collège est un vaste et superbe corps de logis en pierre de taille comme celle de l'église, à quatre étages et à toit mansard, flanqué à droite d'un pavillon qui n'attend que celui de gauche pour donner à l'édifice toute son ampleur et sa beauté.

Il est tenu par des religieux de Sainte-Croix, la plupart canadiens. A la distance où ils sont de la province de Québec, ils n'ont pas souvent occasion de voir des compatriotes, surtout des membres du clergé. Aussi ma visite paraît-elle leur faire un sensible plaisir.

— Soyez le bienvenu, me dit en me serrant vivement la main, le supérieur, l'excellent P. Lefebvre. Vous vous êtes bien fait attendre, car un de nos pères nous a annoncé votre venue pour l'ouverture des classes, mais vous ne pouvez arriver mieux à point. Nous faisons demain l'inauguration de notre nouvelle chapelle, qui fait partie de l'aile que nous venons d'achever, et pour laquelle un de nos anciens élèves, un Acadien, l'abbé

[1] Digues.

Cormier, nous a fait don de trois mille dollars. C'est lui-même qui vient la bénir et chanter la messe ; et c'est vous qui nous donnerez le sermon.

J'ai beau me récrier, alléguer les meilleures raisons du monde, le P. Lefebvre est inflexible ; il n'y a qu'à se soumettre.

Le collège de Memramcook n'a guère plus de vingt ans d'existence (1864), et il marche déjà de pair avec les collèges classiques de la province de Québec. Plusieurs de ceux-ci lui sont même inférieurs sous le rapport de l'organisation matérielle. L'édifice actuel, qui ne date que d'une dizaine d'années, a été construit selon les meilleures conditions hygiéniques ; le système de chauffage à l'eau chaude, la ventilation, la distribution de l'eau dans tous les étages au moyen d'un aqueduc qui n'a pas moins d'un mille de longueur, rien n'y manque, hormis peut-être ce qui fait défaut dans toutes nos maisons d'éducation, je veux dire une salle de gymnase établie d'après un système raisonné, telle qu'il en existe quelques-unes aux Etats-Unis, — système admirable dont le but est de proportionner le développement physique au développement intellectuel, et qui réalise d'aussi près que possible l'axiome antique *mens sana in corpore sano.* Les études se divisent en cours commercial et cours classique, et sont suivies par deux cents élèves, dont le nombre va croissant chaque année. Ce résultat est dû principalement à l'enseignement *pratique* du français et de l'anglais, qui est facilité par le mélange à peu près égal d'élèves parlant l'une ou l'autre langue. Au surplus la situation du collège de Saint-Joseph, sur les confins du Nouveau-Brunswick et de la Nouvelle-Ecosse, au centre même des populations acadiennes, ne pouvait être mieux choisie. Ce concours de circonstances en explique le grand et rapide succès, mais ce succès est dû avant tout à un homme qui restera comme l'insigne bienfaiteur des Acadiens.

Remontez à l'origine de chacune de nos institutions catholiques, vous trouverez un prêtre. Ici encore c'est un prêtre qui apparaît au premier jour, et qui est l'âme de cette œuvre. C'est sous l'inspiration du P. Lefebvre, c'est par son zèle, son énergie, sa persévérance, son habileté administrative, en un mot par toutes les qualités qui distinguent les fondateurs, qu'a été créé et organisé ce magnifique établissement. Le collège de Saint-Joseph est le seul de ce genre, dans les provinces maritimes, qui soit particulièrement dédié aux Acadiens.

On ne saurait exagérer l'importance d'un pareil établissement. Le plus grand malheur des Acadiens n'a pas été leur dispersion, mais l'abandon presque complet dans lequel ils ont été laissés durant près d'un siècle. Dans toute cette douloureuse période, ils n'ont eu, on peut dire, aucun moyen d'instruction. La plupart furent même longtemps sans avoir de missionnaires résidant au milieu d'eux. [1]

On conçoit l'état d'ignorance et de stagnation qui s'en est suivi. Mais de nos jours une ère nouvelle a commencé pour les Acadiens, et elle coïncide précisément avec l'ouverture du collège de Memramcook, qui en a été la principale cause. Il en est sorti toute une pléiade d'hommes instruits, actifs, animés d'un patriotisme ardent et éclairé, qui ont

[1] Le clergé du Canada se trouvait réduit en 1766 à cent trente-huit prêtres séculiers et réguliers ; et l'évêque de Québec, Mgr Briand, était obligé d'envoyer des missionnaires sur tout l'immense territoire qui s'étend depuis l'Acadie jusqu'aux Illinois.

Dans la lettre de mission donnée par ce prélat au P. de la Brosse, le 11 avril 1770, il est dit "qu'il aura à desservir tous les catholiques établis depuis Cacouna et au-dessous jusqu'à l'Acadie, l'Ile Saint-Jean (Prince-Edouard) et l'Ile Royale (Cap-Breton) ;" c'est-à-dire une étendue de pays de plus de cinq cents milles.

fait leur réputation dans différentes carrières, et qui défendent la cause de leurs compatriotes sur tous les terrains de la vie publique et privée. On compte parmi eux des sénateurs, comme M. Poirier, écrivain aussi distingué que sage politique, des députés aux communes et aux législatures provinciales, comme MM. Landry, LeBlanc, Terriault, LeBillois, etc., des avocats, des médecins, des instituteurs et d'excellents prêtres, parmi lesquels il faut compter l'abbé Cormier, curé de Cocagne, l'insigne bienfaiteur du collège dont j'ai déjà mentionné le nom. Chaque année voit s'accroître cette phalange d'hommes remarquables, qui, avec le temps, fera reprendre au peuple acadien la place que ses malheurs lui avaient fait perdre.

IV

6 octobre. — Le soleil se lève radieux et promet une si belle journée que le P. Lefebvre me propose une promenade dans la campagne. Nous irons visiter les bords de la rivière Peticoudiac jusqu'à son embouchure, et nous reviendrons en remontant le cours du Memramcook. — Après le déjeuner, la voiture nous attend au pied du grand escalier en pierre de taille, qui conduit à la porte principale du collège. Pendant que nous descendons l'avenue le père me fait remarquer les cours spacieuses des élèves, les belles plantations qu'il a faites, et qui déjà donnent une ombre agréable durant les chaleurs de l'été. Le chemin de fer *Intercolonial* passe au pied de la colline, et n'attend que l'érection d'une gare nouvelle pour déposer les voyageurs à quelques arpents d'ici.

Voilà devant nous le couvent des sœurs du Sacré-Cœur, et celui des sœurs de la Charité, dont les religieuses sont presque toutes acadiennes. Les sœurs du Sacré-Cœur s'occupent de différentes bonnes œuvres, et veillent en même temps à l'entretien et à la nourriture des élèves du collège. Les sœurs de la Charité tiennent un pensionnat qui est assez nombreux et prospère.

— Cette grande maison que vous voyez près de l'église, me dit le P. Lefebvre, c'est l'ancienne école fondée par mon prédécesseur, le vénérable curé Lafrance. Un de ses frères, qu'il avait fait venir de Québec, y a enseigné pendant quelques années. Les Acadiens n'ont pas eu de meilleur ami que le curé Lafrance. Dieu seul, qui l'a récompensé, connaît les sacrifices qu'il a faits pour l'instruction de la jeunesse. Il a le mérite d'avoir eu, le premier, l'idée d'un collège ici. Il lui a légué toutes ses épargnes et de grandes terres qui donnent actuellement un excellent revenu.

Au nom de ce digne prêtre, le P. Lefebvre aime à associer celui de Mgr Sweeney, évêque de Saint-Jean, N. B., dont la sollicitude est au-dessus de tout éloge. C'est Mgr Sweeney qui en 1864 est allé lui-même à Montréal frapper à la porte des pères de Sainte-Croix pour les prier d'entreprendre l'œuvre de l'enseignement dans son diocèse. Aucune institution ne lui tient plus au cœur que le collège de Memramcook. Sa main est toujours ouverte pour venir en aide aux élèves pauvres qui montrent d'heureuses dispositions, surtout s'ils donnent des espérances pour l'Eglise.

— Ce cheval appartient-il à votre maison, demandai-je au P. Lefebvre, en lui désignant le bel alezan qu'il conduit avec une parfaite dextérité ?

— Ne savez-vous pas, reprend le père avec un sourire satisfait, que nous avons un haras qui nous donnent les meilleures espérances ? Celui-ci en provient. Vous avez raison de le remarquer ; mais je vous en montrerai d'autres que vous admirerez bien d'avantage,

si vous êtes un connaisseur. L'élevage est profitable dans ce pays-ci. Aujourd'hui même j'ai refusé pour une paire de jeunes chevaux un prix qui vous étonnerait et qu'on trouve bien rarement à Montréal ou à Québec.

Le P. Lefebvre s'entend en agriculture aussi bien qu'en enseignement. Curé de la paroisse en même temps que supérieur du collège, il s'intéresse au progrès matériel autant que spirituel de ses paroissiens. Il les réunit pendant les soirées d'hiver, et leur communique le fruit de ses études et de son expérience. Afin d'inspirer du goût pour l'agriculture à ses écoliers, il les fait assister à ses conférences. Il fait préparer d'avance une thèse par l'un deux, et il en prend occasion pour développer ses propres idées, dissiper les préjugés, suggérer des améliorations.

Ces leçons et les résultats qu'il obtient sur les terres du collège, dont il surveille lui-même la culture, ont déjà produit une révolution dans les esprits. Les Acadiens se sont mis à l'œuvre, et ils se piquent d'honneur pour rivaliser avec le P. Lefebvre. Est-il besoin d'ajouter qu'ils apprécient son dévouement, qu'ils l'aiment comme un père, qu'un mot de lui est une parole d'Evangile. Le P. Lefebvre est le souverain de toute cette contrée ; son influence est sans rivale parmi toutes les classes et toutes les nationalités ; le peu que je viens d'en dire prouve qu'il en est digne.

Modeste comme le vrai mérite, le P. Lefebvre rejette la plus large part de ses succès sur ses coopérateurs, qui de fait l'ont merveilleusement compris et secondé. C'est un éloge de plus pour celui qui a su ainsi faire concourir tous les éléments qui l'entouraient à l'établissement de son œuvre.

L'aspect général de ce pays fait songer aux environs de Montréal. A la franche allure des gens, à la politesse et à l'air de connaissance avec lesquels ils nous saluent au passage, on s'aperçoit bien qu'on est dans un pays français et catholique. On le devinerait sans cela à la seule apparence des maisons. Elles n'ont pas cette architecture de fantaisie, ces airs de prétention plus ou moins ridicule qu'on remarque dans les campagnes des Etats-Unis, et qui menacent de s'introduire au Canada. On voit que les propriétaires les ont bâties en vue de leur propre confort et non pour attirer les yeux des passants, et qu'ils ont profité de leur expérience des lieux et du climat. Le site de ces habitations est bien choisi, et leurs ouvertures principales regardent le soleil levant, afin d'en recevoir abondance de lumière et de chaleur. Leur construction simple et régulière est faite de façon à présenter le moins de surface possible au vent et au froid. L'habitant acadien s'y montre tel qu'il est, vrai homme des champs dans le sens antique du mot, en ayant gardé les goûts modestes et les solides qualités.

Le pays que nous parcourons est un terrain d'alluvion assez accidenté, et partout ouvert à la culture. Dans les champs, des groupes d'hommes et de femmes sont occupés activement à faire la dernière récolte, celle des pommes de terre, qui donne ici de magnifiques rendements, car les Acadiens n'ont pas de rivaux pour ce genre de culture.

Grâce à l'allure alerte de notre monture, nous arrivons bientôt sur les hauteurs qui dominent le cours de la rivière Peticoudiac. Le paysage qu'on y a sous les yeux est gracieux et doux comme une idylle. Les deux rives s'élèvent graduellement en amphithéâtres, couronnés d'arbres verts et tachetés de blanc par les maisons proprettes des Acadiens, qui ont l'air heureuses avec leurs granges et leurs remises bien tenues et fermées d'un enclos de palissades blanchies à la chaux. A droite, la vue suit les méandres de la rivière, jusque dans les profondeurs des terres ; à gauche elle s'étend jusqu'à son embouchure qui

s'ouvre en large entonnoir sur la baie de Fundy, dont les eaux bleuâtres se confondent là-bas avec le ciel.

Vous voyez distinctement d'ici, me dit le P. Lefebvre, cette seconde pointe qui s'avance dans la baie et qui ferme l'horizon de l'autre côté du Peticoudiac, c'est la pointe de Chipoudy ; c'est là que vint s'établir, en 1699, le meunier Thibaudeau avec sa famille qu'il amenait de Port-Royal. C'est dans la baie de Chipoudy qu'il bâtit son moulin et établit sa colonie, qui dès son vivant était déjà si florissante. Vous vous rappelez le beau chapitre qu'en a écrit notre ami M. Rameau dans son histoire d'*Une colonie féodale.* C'est une de ses meilleures pages. Le portrait de ce colon entreprenant, de sa vaillante femme et de ses enfants, l'arrivée des familles qui vinrent les rejoindre, les progrès de l'établissement, la satisfaction du vieux Thibaudeau à la vue de ses travaux si bien récompensés, des riches moissons, des troupeaux augmentant d'année en année, la paix et le contentement qui régnaient dans cette solitude, si loin du monde qu'elle semblait à l'abri des moindres dangers, tout cela est tracé avec une vérité saisissante. C'est une délicieuse pastorale ; on serait même tenté de croire, de prime abord, à un tableau de fantaisie fait à plaisir, tant il est frais et séduisant ; mais les documents officiels, les recensements sont là pour attester la réalité des faits. Pendant le demi-siècle qui suivit la mort de Thibaudeau, la colonie de Chipoudy continua à prospérer. Mais, hélas ! aucune trace n'en reste aujourd'hui. Tout a disparu depuis la tourmente de 1755. Des étrangers occupent maintenant leurs foyers, cultivent leurs champs et jouissent des fruits de leurs travaux. Le nom même de Chipoudy, qui rappelait trop le souvenir des malheureux spoliés, a été changé pour un nom moderne.

L'expulsion des habitants de Chipoudy, de Peticoudiac et de Memramcook n'avait pas été effectuée par la ruse comme à Grand-Pré et à Pisiquid, mais par la force ouverte.

Un fort détachement de troupes anglo-américaines, sous le commandement du major Frye, avait fait une descente à Chipoudy et avait brûlé toutes les maisons sur le bord de l'anse, ne laissant intactes que celles qui se trouvaient à l'entrée du bois, où les habitants purent les protéger en faisant feu sur les assaillants.

De là Frye avait jeté une partie de ses hommes sur la rive gauche du Peticoudiac, pour faire mettre le feu à l'église et au village ; mais les habitants avaient eu le temps de se reconnaître et de se réunir avec un parti de sauvages sous les ordres de M. de Boishébert. Ils les surprirent, les cernèrent et en firent un affreux massacre. La moitié resta sur la place, ou fut prise ; le reste s'enfuit vers le rivage et s'abrita derrière les digues, où il se défendit jusqu'à ce que Frye eût le temps de débarquer et de les rejoindre. Il voulut reprendre l'offensive ; mais, après un combat acharné, il fut obligé de se rembarquer en toute hâte.

Mais que pouvait cette poignée d'hommes sans espoir de secours, contre des régiments armés de toutes pièces ? Ils se virent forcés d'abandonner leurs terres et de se réfugier dans les bois, emportant avec eux les objets les plus précieux. Si vous entrez aujourd'hui chez certaines familles acadiennes originaires de Chipoudy, de Peticoudiac et de Memramcook, vous entendrez le récit des scènes navrantes qui se passèrent alors et dont elles ont gardé la tradition.

Un des détachements qui avait le plus harcelé les Bostonnais et les avait forcés de se rembarquer, était commandé par Noël Brassard, vieux chasseur et milicien accoutumé aux guerres de partisans.

Aucun habitant du lieu n'avait plus d'intérêt que lui à défendre ses foyers. Il était père de dix enfants dont le dernier avait à peine huit jours ; il avait avec lui sa vieille mère octogénaire. Son père, l'un des premiers colons de Peticoudiac, lui avait légué, avec la maison paternelle, une grande et belle terre en pleine culture, qui lui donnait une honnête aisance. Aussi Noël Brassard ne pouvait se résigner à la pensée de quitter Peticoudiac pour aller errer dans les bois avec sa famille, aux approches de nos terribles hivers. Il savait quelles misères les y attendaient ; il savait que les plus faibles y trouveraient une mort certaine.

Dans l'assemblée des habitants où le départ fut décidé, Noël Brassard opina pour une lutte à outrance, et ce ne fut qu'après que toute la paroisse eût été abandonnée qu'il se décida à rejoindre les fugitifs.

Pendant que sa femme, qui pouvait à peine se traîner, se dirigeait vers la lisière de la forêt, suivie de ses enfants, et portant le dernier-né dans ses bras, il entassait dans une charrette le peu d'effets qu'il pouvait emporter et y étendait sa vieille mère, que les émotions des derniers jours avaient réduite à l'extrémité. Il eut bientôt rejoint sa famille qui l'attendait sur le haut de la colline d'où l'on apercevait le village à moitié incendié et l'entrée du Peticoudiac.

Ils s'arrêtèrent là silencieux ; les enfants se pressaient autour de leur mère en étouffant leurs sanglots ; pour Noël Brassard, il ne pleurait pas, mais il était pâle comme un mort, et ses lèvres tremblaient quand il regardait sa femme qui soupirait en essuyant ses larmes. Le soleil se couchait en arrière d'eux sur la cime des arbres — un beau soleil clair d'automne qui réjouissait tout le paysage. Ses rayons obliques allumaient des reflets d'incendie sur les fenêtres des maisons, et allongeaient leurs ombres dans la vallée.

La mère Brassard, épuisée de force, avait paru à peu près insensible pendant le trajet ; mais alors elle ouvrit les yeux, et, comme si l'éclat des objets la ranimait, elle se mit à examiner l'une après l'autre chacune des maisons du village ; elle jeta un long regard d'adieu sur le toit où elle avait si longtemps vécu ; puis ses yeux restèrent fixés sur le cimetière dont les tombes et les croix blanches brillamment illuminées se dessinaient en relief sur l'herbe du gazon.

— Je n'irai pas plus loin, soupira-t-elle à son fils ; je me sens mourir. Tu m'enterreras là, près de ton père.

La voiture se remit en marche ; mais, quand elle eut fait quelques arpents sur le chemin cahoteux et mal tracé qui plongeait dans la forêt, Noël Brassard s'aperçut que le visage de sa mère devenait plus blanc que la cire ; une sueur froide perlait sur ses joues.

Sa femme et lui s'empressèrent autour d'elle pour la ranimer, mais ce fut en vain. Elle était morte.

Le lendemain au soir, deux hommes étaient occupés à creuser une fosse dans le cimetière de Peticoudiac. A côté d'eux attendait le missionnaire, M. LeGuerne, qu'ils avaient eu le temps d'aller prévenir. Noël Brassard et son beau-frère se hâtèrent d'achever leur besogne, car la lune, alors dans son plein, montait rapidement à l'horizon et aurait pu facilement trahir leur présence.

Quand la fosse fut terminée, le missionnaire revêtit son surplis avec son étole noire, et récita à voix basse les prières de l'absoute. Il aida ensuite les deux hommes à combler la fosse.

— Avant de partir, leur dit-il, nous allons réciter un *De profondis* au pied de la grande

croix, afin de mettre nos morts sous la protection de Dieu et les défendre contre la profanation des hérétiques.

Un instant après, la porte du cimetière grinça sur ses gonds, et tout rentra dans le silence.

Noël Brassard n'était qu'au commencement de ses tribulations. Malgré ses sinistres pressentiments, s'il eût pu prévoir tous les malheurs qui l'attendaient, il aurait reculé d'épouvante.

Dans le cours de cet affreux hiver, il perdit sa femme et tous ses enfants, hormis deux, un garçon et une fille. De Peticoudiac à Ristigouche, où il arriva dans les premiers jours du printemps, on aurait pu suivre sa marche à la trace des tombes qu'il avait laissées derrière lui.

Dans son désespoir, il ne pouvait entendre prononcer le nom d'un Yankee sans être saisi d'une espèce de frénésie. Il confia les deux enfants qui lui restaient à sa sœur Marguerite d'Entremont, qui elle-même avait perdu tous les siens, et il se remit à son ancien métier de chasseur ; mais cette fois, ce n'était pas pour faire la chasse aux animaux des bois, c'était pour faire la chasse à l'homme, la chasse à tout ce qui portait le nom d'Yankee ou d'Anglais. A la tête de quelques partisans habiles au tir comme lui, et comme lui exaspérés par l'excès du malheur ; il n'épargna rien pour faire à ses ennemis tout le mal qu'il en avait souffert. Pendant les cinq années qui suivirent, il se mit à la disposition des officiers français, qui l'employèrent à soulever les tribus sauvages, et à les accompagner dans leurs sanglantes expéditions. Chaque fois qu'il abattait un ennemi, il faisait une entaille sur la crosse de son fusil. Ce fusil a été conservé par ses descendants, et l'on n'y compte pas moins de vingt-huit marques.

Au printemps de 1760, Noël Brassard était de retour à Ristigouche. Quand le marquis de Danjac vint s'y réfugier avec ses quatre vaisseaux, il réclama le privilège de servir un des canons qui furent débarqués sur la pointe à la Batterie pour défendre l'embouchure de la rivière. Les artilleurs se firent tuer sur leurs pièces, et Noël Brassard, qui s'était battu comme un lion, pointait le dernier canon resté sur son affût, quand il fut coupé en deux par un boulet.

Pendant que nous cotoyons le Peticoudiac, le P. Lefebvre m'intéresse vivement en me rapportant quelques-unes des traditions qu'il a recueillies de la bouche des Acadiens.

— Avez-vous remarqué, me dit-il, le calice dont vous vous êtes servi ce matin, lorsque vous êtes allé dire la messe à l'église ? C'est un calice en argent à coupe dorée, d'un travail fort simple, mais d'un prix inestimable pour nous, car il est aussi ancien que l'Acadie, et il a échappé au désastre du siècle dernier.

Avant de se réfugier dans les bois, les marguilliers qui avaient la charge de l'église en l'absence du missionnaire, l'enfouirent sous terre avec quelques autres pièces d'argenterie. Afin de le retrouver, ils firent une excavation au milieu du cimetière, à la rencontre d'une croix qu'ils tracèrent au moyen de deux cordes tendues d'un angle à l'autre. Dans une requête adressée en 1805, à Mgr Denault, évêque de Québec, par les habitants de la baie Sainte-Marie, on trouve quelques détails précis sur la manière dont furent conservés les vases sacrés et les ornements de plusieurs églises. " Au temps de l'enlèvement des Aca-
" diens, y est-il dit, les ornements et les vases sacrés des églises de nos cantons furent en
" grande partie sequestrés par plusieurs habitants et cachés dans le bois, et ainsi préservés
" du pillage ; ensuite ramassés et remis à feu M. Maillard, missionnaire. Après la mort

" de ce vénérable prêtre, tous ces effets se trouvèrent entre les mains de Louis Petit-
" pas qui avait pris soin de lui durant sa dernière maladie ; mais d'après des ordres précis
" de Mgr l'évêque de Québec, tout fut livré à M. Bailly, missionnaire dans notre province
" Plusieurs de nos habitants ici et à Sainte-Anne d'Argyle ont pleine connaissance de cela.
" M. Bailly en se retirant laissa quelques ornements, entre autres deux anciennes chasubles
" que nous avons ici et deux calices d'entre ceux qui lui avaient été remis ; il emporta le
" reste. Ces deux calices furent laissés à un M. Wealling, chez qui M. Bailly se retirait à
" Halifax. Ce missionnaire ayant cessé de venir en cette province, le dépositaire est de-
" meuré comme investi de ces calices, mais s'en trouvant embarrassé, il les a remis à un
" Acadien nommé Charles-Amand Surette, après les avoir offerts à plusieurs autres, parce
" que apparemment il croyait que les Français y avaient plus de droit que les Irlandais.

" Les choses étaient en cet état, lorsque nous avons eu pour missionnaire M. LeDru,
" français d'origine et religieux dominicain. Ce prêtre étant au Cap-Sable, entendit parler
" de ces calices, et pour les avoir il s'adressa par une requête, dont il existe encore une
" copie, au gouverneur qui autorisa l'envoyé à prendre les calices demandés chez le parti-
" culier qui les avait en dépôt. Muni de la permission de Mgr le gouverneur, le porteur
" s'adressa à Charles-Amand Surette, qui lui remit deux calices avec une petite custode,
" qui furent apportés à M. LeDru, au Cap-Sable. Un de ces calices a été enlevé et laissé à
" Halifax ; Votre Grandeur a eu la bonté d'en ordonner la restitutition." [1]

Il existait jadis, à l'entrée de la rivière Peticoudiac, un village abénaquis assez bien peuplé, mais il en reste aujourd'hui peu de familles, qui vivent la plus grande partie de l'année dans les forêts. Quelques-uns des pères du collège viennent de temps en temps faire l'office et donner des instructions dans leur petite chapelle qui paraît assez bien conservée. Elle est entourée de quelques pauvres chaumières dont plusieurs sont abandonnées. Il n'y a d'apparence de vie que devant une de ces maisons où un groupe de femmes et d'enfants, aux types sauvages fortement accentués, s'occupent à préparer les éclisses de bois dont elles font leurs paniers. Elles suspendent leur travail en nous voyant passer, et nous accueillent du regard avec cette expression de figure et ce maintien qui indiquent le respect traditionnel des sauvages pour les robes noires.

L'embouchure du Memramcook et celle du Peticoudiac sont séparées par un promontoire assez élevé où différentes compagnies américaines ont ouvert des carrières de pierre très facile à travailler et d'une belle couleur gris perle. Une grande partie de cette pierre est transportée aux Etats-Unis et a servi à la construction de plusieurs belles rues de New-York. Je m'explique maintenant le rapprochement qui m'est venu à l'idée, au premier coup d'œil que j'ai jeté sur le portail de l'église et sur le collège de Memramcook.

Nous traversons le promontoire en suivant le chemin de la carrière dont nous côtoyons les immenses fossés, et nous redescendons dans la vallée du Memramcook. Lorsque nous l'avons quittée à notre départ, ses eaux boueuses étaient toutes basses et laissaient à découvert les pentes luisantes et roussâtres de ses rivages. Maintenant la rivière coule à pleins bords et inonderait la campagne si elle n'était pas retenue entre ses deux puissantes jetées.

Dans cette partie de la baie de Fundy, la marée monte avec une extrême rapidité, et s'élève jusqu'à une hauteur perpendiculaire de soixante et quinze pieds. Elle arrive en roulant une vague énorme qui enlève du fond de la baie une épaisse couche de vase ou

[1] *Archives de l'archevêché de Québec.*

limon qu'elle dépose en se retirant. C'est ainsi que se sont formés de siècle en siècle ces vastes estuaires qui sont devenus une des grandes richesses du pays. Le sel marin qui s'y trouve mêlé leur donne une telle fertilité qu'il dispense de tout autre engrais. Il suffit d'y arrêter le cours de la marée et de laisser la pluie laver la surface du sol, qui se couvre bientôt d'une luxuriante végétation. Ces prés naturels n'ont besoin d'autre culture que d'un labour tous les sept ou huit ans. Les récoltes de foin et les pâturages qu'on y fait ont le double avantage d'être abondants et d'une qualité supérieure. Les Acadiens qui en firent les premiers essais ne s'y trompèrent pas. Ils y établirent leurs principales colonies qui, dès la fin du dix-septième siècle, s'étendaient sur tout le littoral de la baie, depuis le bassin des Mines jusqu'à Chipoudy.

La journée était avancée lorsque nous fûmes de retour de notre agréable promenade. Je dis adieu à regret aux professeurs du collège qui, pendant le court séjour que je venais de faire au milieu d'eux, m'avaient autant édifié par leur régularité que charmé par leur politesse. Je crois voir encore la bonne figure réjouie du P. Lefebvre me disant en me donnant une dernière poignée de mains : "Ah! ça, ne l'oubliez pas ; il faut nous revenir bientôt."

V

De la gare de Memramcook à celle d'Amherst, une heure. A mi-chemin, on aperçoit sur la droite, à une petite distance, les ruines de l'ancien fort Beauséjour, aujourd'hui fort Cumberland, assis sur un coteau qui se projette vers l'est et qui domine la magnifique baie, si bien appelée par les Français Beaubassin. Comme l'après-midi était belle, et que le soleil était encore assez haut sur l'horizon, je résolus d'en profiter, et je commandai une voiture au maître de l'hôtel, M. Ward, brave Irlandais catholique, qui m'offrit de me conduire dans la sienne. Chemin faisant, je l'interrogeai sur Amherst et ses environs.

— Nous sommes, me dit-il, dans un pays tout à fait protestant, qui garde encore presque tous les anciens préjugés contre notre religion. Il n'y a ici qu'une poignée de catholiques irlandais et une pauvre petite église desservie par un jeune prêtre irlandais.

De la belle paroisse de Beaubassin, il ne reste pas de vestige. Le fer et le feu y ont été promenés pendant des années ; tout ce qui portait le nom d'Acadien a été traqué comme une bête fauve. Pour en retrouver des débris dans ces parages, il faut aller jusque dans les îles et sur les bords du golfe, ou à l'extrémité méridionale de la Nouvelle-Ecosse.

Au sortir du village d'Amherst, on remarque l'emplacement encore visible du fort Lawrence bâti par les Anglais sur les ruines de celui de Beaubassin. Les remparts qui étaient en terre en ont été abattus et jetés dans les fossés que l'on distingue encore à des plis de terrain où la charrue peut passer. Cet emplacement fait partie d'une ferme dont le propriétaire a bâti sa demeure sur un des bastions. L'*Intercolonial* passe au pied du talus, et coupe la terre où se trouvait le cimetière. On a mis à découvert plusieurs corps, lorsque ce chemin de fer a été construit.

Du fort Lawrence la plaine descend en pente douce jusqu'à la petite rivière Messagouetche, qui servait au siècle dernier et qui sert encore aujourd'hui de frontière à la Nouvelle-Ecosse. De là la plaine remonte graduellement pour former l'éminence sur laquelle repose le fort Cumberland. Avec les projectiles modernes les deux forts pourraient se canonner facilement, car ils ne sont pas distants d'une lieue. Le Messagouetche,

avec ses eaux ternes et fangeuses, avec ses écores roussâtres et ses digues, est une miniature du Peticoudiac. Quand la marée s'est retirée, il n'est plus qu'un ruisseau encaissé qui traîne sans bruit ses eaux limoneuses sur une pente insensible. On le traverserait sans y faire attention, s'il n'évoquait le souvenir des scènes sanglantes dont il a été le théâtre. C'est ici que venaient se rencontrer les partis de guerre stationnés aux deux forts, pour s'en disputer le passage après avoir ravagé les terres et brûlé les moissons des pauvres Acadiens. C'est derrière cette digue, et couchés dans ces grandes herbes, que se tenaient les espions micmacs qui commirent contre l'infortuné Howe ce meurtre qui souleva tant d'indignation dans les deux camps. [1]

Le soleil était près de l'horizon quand je descendis de voiture au pied du fort Cumberland. Lorsqu'on jette un coup d'œil sur le paysage dont on jouit du haut des remparts, on comprend pourquoi les Français donnèrent à ce lieu le nom de Beauséjour. Au reste, ils ont laissé en bien d'autres endroits l'empreinte de l'admiration que leur inspirait ce pays, ce qui atteste en même temps jusqu'à quel point était développé chez eux le sentiment de la nature. Cette belle nappe d'eau qui s'étend au pied du fort *Beauséjour* c'était pour eux la baie de *Beaubassin* avec son fort auquel ils s'étaient plu de donner le même nom. Plus loin, au delà de ces montagnes c'était le *Port Royal.*

Si les conquérants ont fait acte de bonne politique en bannissant ces souvenirs français, ils n'ont guère fait preuve de bon goût. Que rappellent en effet les noms de Lawrence, d'Annapolis, de Cumberland, sinon des personnages d'une valeur médiocre, tandis que les premières désignations exprimaient la beauté des lieux.

Il y a deux siècles, Mgr de Saint-Vallier parlait ainsi de Beaubassin : "Sa situation " est charmante. Cet établissement est au fond d'une baie de six lieues de tour où se " jettent sept belles rivières, et qui communique avec la baie française par un passage qui " n'a qu'une demi-lieue de large, et sans danger." [2]

De son côté l'intendant De Meules écrivait en 1685 : "Il y a tout autour de Beaubassin " une si grande quantité de prairies qu'on y pourrait nourrir cent mille bêtes à cornes ; " l'herbe qui y vient s'appelle *misette*, très propre pour engraisser toutes sortes de bestiaux. " Aux deux côtés des dites prairies, ce sont de douces côtes toutes couvertes de bons bois " francs ; on y a déjà fait plus de vingt-deux habitations sur de petites éminences que les " habitants y ont choisies pour avoir communication dans les prairies et dans les bois.... " Il n'y a aucun de ces habitants qui n'ait trois ou quatre corps de logis assez raisonnables " pour la campagne. Ce lieu de Beaubassin est si heureusement situé pour faire des " nourritures considérables de bestiaux, que si l'on établit à Port-Royal des relations " régulières avec nos îles de l'Amérique, il s'y trouverait assez de bestiaux pour le

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[1] L'abbé Maillard a raconté très au long les détails de cet incident qui a servi de prétexte à des attaques contre les missionnaires, surtout contre l'abbé Leloutre. — (*Lettres de l'abbé Maillard sur les Missions micmaques....Soirées canadiennes*, année 1863.

Si l'on veut se former un jugement impartial sur cette époque, il faut tenir compte, en étudiant les documents français, de l'esprit anti-religieux que Voltaire et les philosophes avaient mis alors en vogue. Les préjugés contre le catholicisme et le clergé n'étaient pas moins intenses parmi les Français que parmi les Anglais.

L'auteur de l'*Histoire de la Nouvelle-Ecosse*, Beamish Murdoch, quoique protestant, fait la même remarque en parlant du jugement qu'il porte sur l'abbé Leloutre. "Il faut cependant se rappeler, dit-il, que nous avons pris nos informations sur ce personnage, de sources qui n'étaient pas amies des prêtres de son église ; les Français de cette époque étant entachés de la philosophie de Voltaire."

[2] *Histoire du séminaire de Québec.*

" commerce des îles, et leur fournir leur provision de bœuf, que l'on tire des pays " étrangers." [1]

Le fort Cumberland est un vaste pentagone dont les remparts assez élevés et bien conservés sont en terre recouverte d'une épaisse couche de gazon. Les courtines sont percées de casemates dont la construction solide a résisté à l'action du temps. On distingue encore parfaitement sur les remparts les embrasures des canons, qui ont tous été enlevés avec le matériel de guerre. La poudrière, placée dans les fossés sous la protection d'ouvrages avancés, est complètement en ruines. Il n'existe à l'intérieur de la forteresse qu'un édifice à toiture défoncée, ouvert à tous les vents, qu'on dit avoir été la caserne des officiers.

Autour de cette masure déserte paissait un troupeau de bétail qui s'enfuit à mon approche jusqu'au bord des bastions, d'où il me regarda d'un air effarouché, comme s'il n'eût jamais été troublé dans cette solitude. Tel est l'état d'abandon et d'oubli dans lequel est tombée cette position stratégique disputée autrefois avec acharnement par les deux puissances rivales. Elles en avaient tout d'abord compris l'importance. Par sa situation à l'endroit le plus rétréci de l'isthme, Beauséjour était la clef de l'Acadie. Il communiquait sur l'océan d'un côté par la baie Française, dont les eaux venaient battre à ses pieds, de l'autre par le golfe Saint-Laurent au moyen du fort Gaspareaux, bâti tout exprès au fond de la baie Verte.

Par malheur, au moment du danger, la garde de ce poste avait été confiée à l'un des mauvais génies de la Nouvelle-France, Vergor, l'ami de Bigot, le même qui plus tard, par lâcheté ou par trahison, devait livrer à Wolfe l'accès des plaines d'Abraham.

Au mois de juin 1755, un fort détachement de troupes anglo-américaines, commandé par Monkton, vint mettre le siège devant Beauséjour. Vergor n'avait à leur opposer que cent-cinquante hommes de troupes régulières ; mais il eût pu le repousser avec l'aide des quinze cents Acadiens et sauvages réfugiés autour du fort, s'il ne les eût d'avance indisposés contre lui par d'indignes traitements, et en leur refusant le nécessaire, tandis que les magasins étaient remplis. [2]

Pendant que la voiture m'emportait du côté d'Amherst, au moment où le soleil couchant jetait ses derniers rayons sur les grands prés et sur la baie de Beaubassin, je ne pus me défendre d'un sentiment de tristesse en songeant à la perte irréparable que la France a faite de cette admirable contrée et du vaillant peuple qui l'avait colonisée. La cour de Versailles a eu bien des torts vis-à-vis de la Nouvelle-France ; mais nulle part l'ingratitude et l'impéritie de cette cour ne sont plus sensibles que sur cette terre acadienne, toujours fidèle et toujours sacrifiée. Si on y eût dépensé seulement la moitié de ce qu'a coûté le château de Versailles, on pourrait compter aujourd'hui un million d'Acadiens richement établis autour de la baie, qui n'aurait pas perdu le nom de baie Française.

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[1] *Archives de la marine à Paris.*

[2] C'est à Vergor que l'intendant Bigot écrivait: " Profitez, mon cher Vergor, de votre place (de Beauséjour) ; taillez, rognez, vous avez tout pouvoir, afin que vous puissiez bientôt me venir joindre en France, et acheter un bien à portée de moi."

Le fait suivant peint l'administration de Vergor. Afin d'arracher aux Acadiens le peu d'argent qui leur restait, il leur défendait d'aller s'approvisionner chez les Anglais, et il leur vendait les effets que le gouvernement français envoyait pour leur propre soutien.

VI

D'Amherst à Truro, au fond de la baie de Cobequid, soixante-treize milles. Cette petite ville anglaise a pris la place de la paroisse acadienne de Cobequid, anéantie en même temps que les Mines. Il en a été de même de Pisiquid, aujourd'hui Windsor, qui rivalisait de prospérité avec Cobequid où il y avait deux églises, l'une pour les blancs, l'autre pour les sauvages sur la rive opposée. Le même missionnaire pouvait ainsi desservir les deux églises et partager également ses soins entre les chrétiens des deux races. On saisit ici sur le fait la supériorité de la colonisation française sur celle de nos voisins, sous le rapport de l'humanité et de la civilisation. Le voisinage de ces deux églises, dans une mission composée de blancs et de peaux rouges, vivant côte à côte dans une constante amitié, indique l'esprit qui chez nous animait l'Eglise et l'Etat. La colonisation française a été un bienfait pour les indigènes, tandis que celle de l'Angleterre a été pour eux une calamité. Leur instinct ne se trompait pas quand il leur faisait voir dans les Français des frères et des amis, et dans les Anglais des indifférents ou des ennemis. Ceux-ci ont eu à souffrir davantage de leur barbarie, précisément parce qu'ils n'ont cherché à se les concilier que lorsqu'ils y ont été poussés par leur propre intérêt. Conçoit-on après cela qu'on nous fasse un reproche de ne pas avoir mieux réussi à humaniser les sauvages, tout en avouant que leur génie était réfractaire à la civilisation ? Nos pionniers et nos missionnaires n'ont-ils pas poussé l'héroïsme et la persévérance jusqu'à leurs limites ? S'il y a responsabilité quelque part, ne retombe-t-elle pas de tout son poids sur ceux qui, au lieu de seconder leurs efforts, ont plutôt cherché à les entraver ?

De Truro à Windsor le trajet en voiture le long de la baie de Fundy peut se faire en quelques heures ; mais il n'y a de communication par voie ferrée qu'en passant par Halifax.

VII

8 octobre. — Kentville, à sept milles de Grand-Pré, anniversaire du premier embarquement des Acadiens. Kentville est un village agréablement situé sur les bords de la rivière Cornwallis qui se jette dans le bassin des Mines. Hier au soir, en descendant à la gare, j'ai fait l'heureuse rencontre de M. Lyon, irlandais d'origine, qui a vécu longtemps tout auprès de Grand-Pré, dans la ville naissante de Wolfeville. Il est familier avec tous les souvenirs qui se rattachent à Grand-Pré.

Je commande une voiture et je profite de l'offre qu'il me fait de m'accompagner.

Le soleil levant commençait à dissiper une brume épaisse qui s'était levée pendant la nuit de la baie de Fundy, et faisait présager une journée claire et agréable.

L'aspect général du pays est bien différent de celui que présente le fond de la baie. Les hauteurs qui lui servent ici de contreforts sont très bien accentuées et sont rayées de ravins au fond desquels coulent plusieurs rivières qui se jettent dans le bassin des Mines : la rivière aux Canards, celle des Habitants et celle de Gaspareaux gardent encore leurs noms acadiens.

On a dit avec raison que ce littoral qui comprend les trois comtés d'Annapolis, Kings et Hants, est le jardin des Provinces Maritimes. On peut en effet traverser ces trois comtés presque sans sortir des vergers. Outre les cerisiers, les pruniers et les poiriers, les

plus belles variétés de pommes y réussissent admirablement. De chaque côté du chemin que nous suivons, d'innombrables pommiers sont chargés à se rompre de fruits superbes. Certaines variétés, telles que la pomme Béliveau, portent encore le nom des Acadiens qui, les premiers, les ont cultivées. Dès la fin du dix-septième siècle, les arbres fruitiers étaient une des grandes ressources du pays.

" Il y a des endroits, écrivait Dièreville en 1700, aussi bien plantés de pommiers qu'en Normandie. "

Comme nous descendions la déclivité au bas de laquelle s'élevaient l'église et le village de Grand-Pré, le soleil achevait de disperser les brumes à l'horizon, et diamantait les eaux du bassin. A notre gauche le cap Blomedon, l'ancien cap Doré des Français, dont la falaise roussâtre, à demi déboisée, s'allonge pour former l'anse des Mines, se dégageait lentement des buées blanches qui flottaient à son sommet et à l'embouchure des rivières aux Canards et des Habitants, tandis qu'à une demi-lieue vers la droite la rivière Gaspareaux étalait en serpentant dans la plaine, sous un ciel éclatant, la surface argentée de ses eaux, qu'elle dégorgeait avec la marée baissante dans l'entrée du bassin. Au-dessus du vaste plateau qui a donné son nom à Grand-Pré, et qui n'a pas moins de deux ou trois milles de longueur sur une largeur de plus d'un mille, erraient de petits nuages isolés, semblables à un troupeau de brebis paissant dans l'azur du ciel.

Quand on est descendu au bas de la colline sur laquelle est groupé le village de Wolfeville, on a devant soi une campagne tranquille et solitaire comme aux jours des Acadiens. La Grand'Prée, entourée de ses puissantes digues est toujours une commune qui sert de pâturage aux bestiaux, dont on aperçoit des groupes disséminés çà et là dans le lointain.

Le chemin qui conduisait au village est marqué par une rangée de saules très anciens. Une autre rangée plus ancienne encore traverse le terrain qui appartenait à l'église. Un de ces saules que j'ai eu la curiosité de mesurer n'a pas moins de vingt pieds de circonférence. Quoique la croissance de cette espèce d'arbres soit rapide, il n'y a cependant pas de doute que ceux-ci n'aient été témoins des scènes de l'expulsion.

Le site qu'occupaient l'église et ses dépendances est redevenu un champ désert. Le sol a été nivelé et l'herbe pousse drue autour des pierres que la charrue a arrachées aux fondations.

Le seul ouvrage de main d'homme qui ait été respecté est un puits, d'où l'on tire une eau excellente, et qui servait à l'usage de la mission.

Quoique le site soit charmant, aucun des nouveaux occupants n'a voulu s'y bâtir, soit que ce lieu rappelât trop vivement des souvenirs qu'on n'aimait pas à réveiller, soit que l'on craignit que ce séjour ne portât point bonheur. Au dire de mon guide, les gens de l'endroit ne parlent pas volontiers de ceux qui les ont précédés, et j'ai trouvé moi-même fort peu communicatifs ceux que j'ai interrogés.

VIII

Pour bien connaître quelle était la position des Acadiens dans la Nouvelle-Ecosse, à la date de leur expulsion, il est nécessaire de remonter jusqu'au traité d'Utrecht (1713). D'après ce traité, l'Acadie était cédée par la France à l'Angleterre, et les colons français de

cette province, qui reçut alors le nom de Nouvelle-Ecosse, passaient sous la couronne d'Angleterre. Mais par une clause spéciale du traité, le libre exercice de la religion catholique était garanti aux Acadiens, et une année de délai était accordée à ceux d'entre eux qui préféreraient se retirer de la province.[1] Peu de jours après la signature du traité (11 avril 1713), la reine Anne enleva cette restriction et prolongea le délai indéfiniment.[2]

Le serment d'allégeance que leur fit prêter l'un des premiers gouverneurs d'Annapolis, le général Richard Philipps, contenait la condition expresse qu'ils ne porteraient pas les armes contre les Français ni contre les sauvages. Cette condition lui parut nécessaire pour engager les Acadiens à rester attachés à la province, dont ils étaient les seuls habitants. De là le nom de *neutres* (*French neutrals*) qui leur fut donné depuis.

Il était facile de prévoir qu'un pareil régime ne pouvait aboutir qu'à des résultats funestes pour le petit peuple naissant, qui se trouvait ainsi placé entre deux puissances rivales, toujours prêtes à en venir aux mains, et qui ne manqueraient pas de se disputer sa neutralité. Il était fatalement destiné à être victime ; mais son infortune a dépassé toute prévision.[3]

Quoique, en général, le joug des gouverneurs anglais ne fût pas sévère, cependant quelques-uns d'entre eux molestèrent les Acadiens et les mécontentèrent par des actes arbitraires, principalement en entravant leurs missionnaires dans l'exercice légitime de leur ministère. Ainsi on voulut les forcer à rejeter l'autorité de l'évêque de Québec, de qui ils relevaient, et à violer par là les règles les plus élémentaires de la hiérarchie catholique.[4] On alla jusqu'à vouloir disposer des cures, à déplacer des curés et à les remplacer par d'autres. Ainsi le P. Félix Pain, curé des Mines, s'étant attiré la disgrâce du gouverneur Armstrong, espèce de maniaque qui finit par se suicider, celui-ci prit sur lui de l'enlever de sa cure et de nommer à sa place le F. Isidore, moine récollet frappé d'interdiction, qu'il aurait maintenu dans ce poste, si les paroissiens des Mines ne s'étaient révoltés et n'avaient chassé cet intrus.[5]

On avait aussi empêché les Acadiens de bâtir de nouvelles églises et de réparer les anciennes. On en avait même démoli quelques-unes : à la Prée-Ronde de Port-Royal entre autres. Certains gouverneurs voulurent même imposer des lois aux missionnaires jusque dans l'administration des sacrements de l'église.[6] Ainsi, par exemple, le gouverneur Mascarène écrivit des lettres de menaces à l'abbé Desenclaves, parce qu'il avait refusé l'absolution à des individus qui refusaient de faire les restitutions auxquelles ils étaient obligés.

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[1] *Archives de la Nouvelle-Ecosse*, p. 12. [2] *Idem*, p. 15.

[3] Le second gouverneur anglais à Port-Royal, le colonel Vetch, évaluait en 1713 la population acadienne à deux mille cinq cents âmes. " Les Français, écrivait-il aux lords du commerce, sont, avec les sauvages, les seuls habitants de ce pays ; et, comme ils ont contracté des mariages avec les sauvages qui sont de même religion, ils ont sur eux une puissante influence. Cent Français, nés dans le pays, parfaitement accoutumés comme ils le sont aux forêts, habiles à marcher en raquettes et à conduire des canots d'écorce, sont de plus grande valeur et d'un plus grand service que cinq cents hommes nouvellement arrivés d'Europe. Il faut en dire autant de leur habileté à la pêche et à la culture du sol. " — *Archives de la Nouvelle-Ecosse*, p. 6.

[4] *Archives de l'archevêché de Québec.* — Toutes ces archives ont été compulsées, et celles du séminaire de Québec, qui l'ont déjà été en partie, le seront entièrement avant la publication définitive de ce travail.

[5] *Documents, notes et traditions sur l'Acadie* recueillis par M. Sasseville, curé de Sainte-Foye. — Je suis redevable à M. l'abbé Sasseville, qui s'occupe depuis de longues années de l'histoire du Canada, d'une foule de précieux renseignements sur l'Acadie. — *Archives de la Nouvelle-Ecosse* — passim.

[6] *Histoire de la Nouvelle-Ecosse, par B. Murdoch*, v. I, p. 409.

Ces procédés vexatoires firent naître des défiances dont profitèrent les émissaires français pour engager une partie des Acadiens à violer la neutralité qu'ils avaient promise. Ce fut là le commencement des interminables querelles au sujet du serment, qui allèrent toujours en s'envenimant jusqu'à la catastrophe de 1755.

Le gouverneur Cornwallis et ses successeurs mirent en œuvre toutes les mesures de persuasion et de menaces pour arracher aux Acadiens un serment *sans réserve.*

Il faut bien se rappeler quelles étaient les lois de la Grande-Bretagne contre les catholiques à cette date, et sous quel joug étaient alors courbés les Irlandais, pour saisir toutes les conséquences que pouvait entraîner un tel serment. Les missionnaires des Acadiens, gardiens de leur foi, n'étaient-ils pas justifiables de manifester leurs craintes à ce sujet? Pouvaient-ils même, en conscience, ne pas leur en faire voir les dangers ? [1]

Ce fut pour mettre un terme à toutes ces vexations, et aussi pour obéir aux sollicitations qui leur étaient faites de venir s'établir au Canada que, au printemps de 1750, les Acadiens adressèrent au gouverneur Cornwallis une requête pour demander l'autorisation de quitter la province.

C'était le seul parti raisonnable qu'ils avaient à suivre, puisque d'une part ils ne voulaient pas prendre plus d'engagements vis-à-vis du gouvernement anglais que n'en avaient pris leurs pères, et que de l'autre on exigeait d'eux des formules de serment de plus en plus sévères.

Le gouverneur répondit qu'ils n'avaient qu'à se conformer aux règlements établis dans la province pour les personnes désirant en sortir, c'est-à-dire qu'à se munir de passeports ; et " que rien ne l'empêcherait d'accorder de tels passeports à tous ceux qui lui en demanderaient." Ce consentement, qui était un aveu éclatant de la justice de leur demande, n'était au fond qu'un leurre destiné à dissimuler un refus réel, que le gouverneur n'osait affirmer tout haut de crainte de voir les Acadiens lui échapper.

Il ajoutait dans sa réponse que, pour le moment, il ne pouvait pas accorder de passeports, qu'il fallait attendre que la paix fut rétablie dans la province. Mais, continuait-il, vous pouvez vous en reposer sur ma parole (*you can rely upon my word*) : aussitôt que la tranquillité sera rétablie, nous donnerons des passeports à tous ceux qui en demanderont."

Dans le reste de sa réponse, il employait tour à tour la persuasion et les menaces pour les retenir. " Mes amis, leur disait-il entre autres choses, du moment que vous avez déclaré votre désir de partir et de vous soumettre à un autre gouvernement, notre détermination a été de n'empêcher personne de suivre ce qu'il s'imagine être son intérêt.... Mais nous vous avouons franchement que votre détermination de partir nous fait de la peine. Nous connaissons bien votre industrie et votre tempérance, et nous savons que vous n'êtes adonnés à aucun vice, ni à aucune débauche.... Vous possédez les seules terres cultivées de la province ; elles produisent assez de grain et nourrissent assez d'animaux pour suffire à toute la colonie.... Cette province est votre pays ; vous et vos pères l'avez cultivée ; naturellement vous devriez jouir des fruits de votre travail." [2]

Le gouverneur concluait en leur rappelant l'obligation de prêter serment, mais sans oser l'exiger de fait, de crainte de les voir partir ; puis il leur défendait de faire des

[1] Le serment du Test ne fut aboli dans la Nouvelle-Ecosse qu'en 1827. Ce fut Haliburton, élu par les Acadiens du comté de Clare (baie Sainte-Marie) qui le fit abolir. Il faut lire le beau portrait qu'il fit des Acadiens et de leur missionnaire, l'abbé Sigogne, dans le discours qu'il prononça à cette occasion.

[2] *Archives de la Nouvelle-Ecosse*, p. 139 et suivantes.

assemblées sans une permission spéciale. Enfin il leur déclarait que ceux qui s'éloigneraient ne pourraient emporter aucun de leurs effets avec eux, et que tous leurs biens seraient confisqués.

En d'autres termes, c'était les déclarer prisonniers. C'était aussi violer ouvertement la clause XIV du traité d'Utrecht, où il était " expressément pourvu à ce que les sujets du roi de France auraient la liberté de se retirer en aucun lieu qu'ils jugeraient convenables, avec tous leurs effets mobiliers." On a vu que le terme d'un an, d'abord fixé, avait été prolongé indéfiniment par la reine Anne.

La réponse du gouverneur Cornwallis contenait cependant deux aveux qu'il est très important de noter, parce qu'ils sont une confirmation du traité. D'abord il reconnaissait pleinement le droit qu'avaient les Acadiens de quitter la province ; ensuite il engageait sa parole de les laisser partir dès le premier moment favorable.

Les Acadiens ne se faisaient guère illusion sur cette dernière condition. Ils voyaient clairement que le gouverneur ne cherchait qu'à gagner du temps. Aussi poursuivirent-ils leurs démarches. Frustrés de ce côté, ils s'adressèrent à la cour de France, où ils firent parvenir leurs requêtes. Le roi et ses ministres finirent par s'en émouvoir, et l'ambassadeur de France à Londres fut chargé au mois de mai 1755 de proposer au roi d'Angleterre d'accorder trois ans aux habitants français de la péninsule, pour s'en éloigner avec leurs effets, et de leur donner tous les moyens nécessaires pour faciliter ce transport.

Le roi d'Angleterre ne crut pas devoir accéder à cette demande, donnant pour raison que *ce serait priver la Grande-Bretagne d'un très grand nombre de sujets utiles.*

Il faut rendre cette justice au cabinet de Londres que, en communiquant au gouverneur de la Nouvelle-Ecosse ce refus de laisser émigrer les Acadiens, il lui enjoignait " d'user de la plus grande précaution et de la plus grande prudence, de peur, ajoutait la " dépêche, que, par leur départ, le roi de France ne profitât d'un si grand nombre de sujets " utiles."

On verra par ce qui va suivre de quelle manière le gouverneur Lawrence, second successeur de Cornwallis, exécuta les ordres du cabinet de Londres.

IX

Quelques historiens ont voulu nier que la convoitise des colons anglo-américains ait été une des causes de l'expulsion des Acadiens ; mais il n'y a qu'à ouvrir la collection des documents officiels de la Nouvelle-Ecosse pour en trouver la preuve :

" Ils possèdent les meilleures et les plus grandes terres de cette province, écrivait en 1754 le gouverneur Lawrence[1] aux lords du commerce, et je ne puis m'empêcher de penser qu'il serait beaucoup mieux, s'ils refusent de prêter serment, qu'ils en fussent chassés." [2]

D'autre part, les lords du commerce lui répondaient le 20 octobre suivant :

[1] Lawrence avait été nommé lieutenant-gouverneur de la Nouvelle-Ecosse en 1754.

[2] They possess the best and largest tracts of land in the Province... I cannot help being of opinion that it would be much better, if they refuse the oaths, that they were away. — *Extract from a letter of Governor Laurence to Lords of trade,* August 1st, 1754. — *Selections from the Public Documents of the Province of Nova Scotia,* p. 213.

"Si le juge en chef est d'opinion qu'en refusant de prêter serment sans réserve, ou en désertant leurs établissements pour se joindre aux Français, ils ont forfait à leur titre de propriété, nous désirerions que des mesures efficaces fussent prises pour mettre à exécution par un procédé légal une telle forfaiture, afin de vous mettre en moyen de concéder leurs terres à toutes personnes désirant se fixer en cet endroit, où nous croyons qu'un établissement serait d'une grande utilité, s'il pouvait être effectué dans l'état actuel des choses ; et comme M. Shirley [1] a insinué dans une lettre à Lord Halifax qu'il est probable *qu'on pourrait se procurer un nombre considérable d'habitants de la Nouvelle-Angleterre pour s'y établir*, vous feriez bien de le consulter sur ce sujet." [2]

Si les colons américains ne sont pas venus s'emparer des terres des Acadiens immédiatement après leur expulsion, c'est qu'il était trop dangereux de s'y fixer à cause du voisinage de ceux des habitants qui s'étaient réfugiés dans les bois avec les sauvages. [3]

La chute du fort Beauséjour, qui mit presque toute la presqu'île aux mains des Anglais, décida du sort des Acadiens. Quoiqu'on en ait dit, la prestation du serment qu'on avait cessé de leur demander ne les aurait pas sauvés ; car elle ne leur eût arraché du cœur ni leur attachement à leur religion, ni leurs sympathies pour les Français. Au fond ce fut là leur grand crime, qualifié par les uns de *fanatisme*, par les autres d'*héroïsme*, selon le point de vue où chacun se place. La preuve, c'est que ceux d'entre eux qui avaient prêté serment ne furent pas plus épargnés que les autres ; ils furent comme eux condamnés à la déportation.

Détestés par les Anglais, contre lesquels un certain nombre d'entre eux étaient toujours plus ou moins prêts à se liguer malgré leurs intérêts, délaissés par les Français du moment que ceux-ci ne pouvaient plus se servir d'eux comme d'instruments, ils n'avaient de véritables amis que les missionnaires, dont les conseils leur paraissaient les plus désintéressés. Peut-on leur reprocher d'avoir eu complètement tort en écoutant leurs avis ?

Les missionnaires n'ont-ils pas été les seuls qui leur soient restés fidèles dans leur malheur ? L'abbé Maillard, par exemple, l'un des plus remarquables, n'a-t-il pas continué à servir ceux qui s'étaient réfugiés dans les parages du golfe ? N'est-il pas mort au milieu d'eux, usé de fatigues et de privations ? [4]

L'abbé Desenclaves n'a-t-il pas vécu dans les bois avec ceux qui avaient cru trouver

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[1] Gouverneur du Massachusetts.

[2] .... If the Chief Justice should be of opinion that, by refusing to take the oaths without a reserve, or by deserting their settlements to join the French, they have forfeited their Title to their Lands, we could wish that proper measures were persued for carrying such forfeiture into execution by legal process, to the end that you might be enabled to grant them to any person desirous of settling there, were we apprehend a settlement would be so great utility, if it could, as Mr. Shirley has hinted in a letter to the Earl of Halifax, that there is a probability of getting a considerable number of People from New-England to settle there, you would do well to consult him upon it. — *Extract from a letter of Lords of Trade and Plantations to Governor Lawrence*, Whitehall, October 29th, 1754, p. 237.

[3] Ce n'était pas le désir qui faisait défaut. Joshua Winslow écrivait du fort Lawrence au colonel Winslow en date du 23 septembre 1755 : "You have a fine Parcel of Stock. (C'est ainsi qu'il désignait les captifs acadiens). I wish they were Equally Distributed among a number of Good Familys *and the Lands well Settled*." — *Journal du colonel Winslow; extraits publiés par la Société Historique de la Nouvelle-Ecosse*, v. III, p. 139.

Cette convoitise datait d'un demi-siècle ; elle avait été l'un des motifs qui avaient engagé, en 1710, les provinciaux de la Nouvelle-Angleterre à s'enrôler dans l'expédition de Nicholson contre Port-Royal. — *Collections of Nova Scotia Historical Society*, v. IV, p. 22.

[4] A Halifax, où il mourut en 1768, il fut assisté à ses derniers moments par des Acadiens et des sauvages.

une retraite du côté du Cap-Sable, jusqu'à ce que, traqué par les Anglais, il eût été fait prisonnier avec les siens et jeté sur les côtes de la Nouvelle-Angleterre ?

Et l'abbé Leloutre lui-même, dont la conduite fut inexcusable à certains égards, et qui s'attira les justes reproches de son évêque, n'eut-il pas, du moins, le mérite de payer de sa personne, d'exposer sa vie bien des fois pour ses ouailles ? [1] Si les Acadiens l'avaient écouté lorsqu'il les pressait d'émigrer, lorsqu'il leur disait qu'ils étaient sur un volcan, qu'ils n'avaient pas de pires ennemis que ceux qui les entretenaient dans une fausse sécurité, n'auraient-ils pas échappé à la déportation ? Et, au moment de la crise, si sa bravoure et son infatigable énergie eussent été secondés par Vergor, n'aurait-il pas pu rallier les Acadiens et les sauvages des environs de Beauséjour, empêcher la chute de ce fort, et par là même rendre impraticable l'attentat des Mines ? A son retour en France, après sa captivité en Angleterre, n'a-t-il pas passé le reste de ses jours à réunir les Acadiens dispersés dans les ports d'Agleterre et à les former en paroisse à Belle-Ile en mer ?

Il est risible de lire les attaques dirigées dans le temps et aujourd'hui même contre les missionnaires des Acadiens. On leur a fait un crime impardonnable de leur attachement à la France, et d'y avoir exhorté les Acadiens. Quelques-uns ont sans doute manqué de prudence et ont poussé trop loin leur zèle patriotique : leur devoir leur imposait une certaine réserve ; mais n'était-ce pas une intolérable tyrannie que d'exiger d'eux davantage ? Les Prussiens de nos jours tiennent une main de fer sur le clergé de l'Alsace-Lorraine ; mais qui songe à faire un crime à celui-ci de rester fidèle à la France, et d'entretenir le peuple dans ce sentiment ?

Il faut lire les documents relatifs à l'Acadie pour se faire une idée des tracasseries et des insultes auxquelles étaient soumis les missionnaires. Outre un serment sévère qu'on exigeait d'eux, ils étaient soumis à un espionnage continuel, et ils n'avaient pas même la liberté de sortir de la province sans un permis spécial.

C'étaient des hommes modérés, [2] écrivait d'eux en 1791 un des agents les plus actifs de la déportation, l'honorable Brook Watson. Et cependant, sur une vingtaine de missionnaires qu'eurent les Acadiens de 1713 à 1755, huit furent bannis et plusieurs autres jetés en prison.

L'évêque de Québec, dont le clergé était peu nombreux, avait toutes les peines du monde à envoyer des prêtres dans ces ergastules de la Nouvelle-Ecosse. Le clergé qui trouvait un ministère pastoral beaucoup plus facile au Canada, refusait de s'y rendre ; et l'évêque avait fini par déclarer qu'il n'enverrait plus de missionnaires chez les Acadiens. Ce ne fut qu'à force de supplications de leur part qu'il consentit à s'occuper d'eux plus longtemps.

X

Lorsque, après la prise de Beauséjour, Monckton communiqua au colonel Winslow, les instructions secrètes qu'il avait reçues du gouverneur Lawrence pour l'expulsion des Acadiens, les Anglo-Américains étaient sous l'impression toute vive de l'humiliante défaite

[1] Le gouverneur Cornwallis avait offert cent livres sterling pour sa tête.

[2] *Collections of the Nova Scotia Historical Society*, v. II, p. 150.

de Braddock à Monongahela. Les alarmes et le surcroît d'animosité qu'avait excités ce désastre expliquent en partie la manière barbare dont cet ordre fut préparé et exécuté.

Mais il faut bien avouer aussi qu'il était difficile de trouver un groupe d'hommes mieux faits pour tramer et accomplir une telle entreprise : chefs et soldats étaient animés du même esprit. Lawrence, qui en fut le principal organisateur, s'est peint lui-même dans une proclamation signée de sa main en 1756. Par cette proclamation, il promettait une récompense de trente livres sterling pour chaque prisonnier sauvage, du sexe masculin, au-dessus de seize ans, amené vivant ; vingt-cinq livres pour chaque scalpe de guerrier sauvage et la même somme pour chaque *sauvagesse* ou enfant amené vivant.[1] C'était le même Lawrence qui reprochait aux Acadiens de lui enlever l'amitié des sauvages.

Murray, dont on connaîtra le caractère par la suite de ce récit, écrivait à Winslow en lui parlant des troupes : " Vous savez que nos soldats détestent les Acadiens, et que, s'ils peuvent seulement trouver un prétexte pour les tuer, ils les tueront." [2]

Embarqué le 14 août, à Beauséjour, avec un détachement de trois cent treize miliciens de la Nouvelle-Angleterre, Winslow descendit la baie de Chignectou, et, profitant de la marée, pénétra dans le bassin des Mines, où il vint jeter l'ancre en face de Grand-Pré.

Le vétéran américain, qui avait accepté cette mission indigne d'un soldat, n'avait pas l'âme tranquille, car il avait la conscience du rôle odieux qu'on lui faisait jouer, et de la flétrissure qu'il allait attacher à son nom. Plusieurs passages de son *journal* laissent

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[1] *Histoire de la Nouvelle-Ecosse*, par B. Murdoch, v. I, p. 308.

[2] *Journal de Winslow*, p. 107.

Beamish Murdoch dans son *Histoire de la Nouvelle-Ecosse*, v. II, p. 47, cite le jugement de l'amiral Knowles sur les soldats anglo-américains qui composaient la garnison de Louisbourg où il commandait : He calls the New-England soldiers lazy, dirty and obstinate : " Every one I found, here, from the generals down to the corporals, were sellers of rum."

L'extrait suivant d'une lettre du rév. Hugh Graham au rév. Dr Brown, d'Halifax, datée de 1791, achèvera de faire connaître le caractère des soldats américains :

" A party of rangers of a regiment chiefly employed in scouring the country of the deluded French who had unfortunately fallen under the bann of British policy, came upon four Frenchmen who had all possible caution, ventured out rom their skulking retreats to pick some of the straggling cattle or hidden treasure. The solitary few, the pitiable four, had just sat down weary and faint on the banks of the desert stream in order to refresh themselves with some food and rest, when the party of Rangers surprised and apprehended them, and as there was a bounty on Indian scalps, a blot, too, on England's escutcheon, the soldiers soon made the supplicating signal the officer's turned their backs, and the French were instantly shot and scalped. A party of the Rangers brought in one day 25 scalps, pretending that they were Indian's, and the commanding officer at the fort, then Col. Wilmot, afterwords Governor Wilmot (a poor tool) gave orders that the bounty should be paid them. Capt. Huston who had at that time the charge of the military chest, objected such proceedings both in the letter and spirit of them. The Colonel told him, that according to law the French were all out of the French, that the bounty on Indian scalps was according to : " Law, and that tho' the law might in some instances be strained a little, yet there was a neces- " sity for winkin : at such things." Upon account, Huston, in obedience to orders, paid down £250, telling that the " curse of God should ever attend such guilty deeds." A considerable large body of the French were one time surprised by a party of the Rangers on Peticoudiac River ; upon the first alarm most of them threw themselves into the river and swam across, and by way the greater part of them made out to elude the clutches of these bloody hounds, tho' some of them were shot by the merciless soldiery in the river. It was observed that these Rangers, almost without exception, closed their days in wretchedness, and particularly a Capt. Danks who even rode to the extreme of his commission in every barbarous proceeding. In the Cumberland insurrection (late war) he was suspected of being " Jack on both sides of the bush," left that place, Cumberland, in a small jigger bound for Windsor, was taken ill on the passage, thrown down into the hold among the ballast, was taken out at Windsor, is half dead, and had little better than the burial of the dog. He lived under a general dislike and died without any to regret his death."

entrevoir les remords qui l'agitaient. Au reste, il aurait fallu avoir dépouillé tout sentiment humain pour n'être pas ému à la pensée de tant de malheurs dont il allait être un des premiers auteurs. Sans doute, à ses yeux, les Acadiens étaient de grands criminels ; ils avaient résisté aux promesses aussi bien qu'aux menaces qu'on leur avait faites ; ils étaient un perpétuel danger pour son pays. Mais il se disait aussi que leur entêtement, qu'il qualifiait de stupide, avait pour mobile un sentiment que les hommes ont toujours respecté : celui de la religion et du patriotisme. Il ne pouvait se dissimuler qu'il y avait de la sincérité dans leur croyance, quelque superstitieuse qu'elle lui parût, et dans leur patriotisme puisqu'ils y sacrifiaient leurs intérêts ; et il pressentait que l'avenir serait plus sévère pour sa conduite que pour celle de ses victimes.

" J'en ai pesant sur le cœur et sur les mains, écrivait-il.... J'ai hâte d'en avoir fini avec cette besogne, la plus pénible dans laquelle j'aie jamais été employé." [1]

Autour de lui se déroulait une nature riante, où tout respirait le calme et le bonheur de la vie champêtre. L'horizon bleuâtre des montagnes qui ferment au nord le bassin des Mines, et les âpres falaises, couronnées de forêts, du cap Blomedon qui en protège l'entrée, étaient noyés dans l'atmosphère chaude et vaporeuse du soleil d'août. Les eaux du bassin, gonflées par le flux, s'épanouissaient comme une nappe de lumière, en emplissant les digues et les rivières aux Canards, des Habitants, de Gaspareaux, dont les rivages étaient animés par des groupes de jeunes gens et d'enfants attirés par la curiosité.

Au bord de l'eau s'étendait à perte de vue la Grand'Prée, toute jaunissante de moissons, ou animée par les troupeaux qui paissaient le riche gazon ; et au-delà, sur les pentes verdoyantes des coteaux qui entourent le bassin, étaient disséminées les maisons simples et rustiques des Acadiens, avec les villages de Grand-Pré et de la rivière aux Canards, surmontés des clochers de leurs églises, qui se dessinaient sur l'arrière plan des hauteurs boisées qui encadrent l'horizon.

Les habitants, dispersés dans leurs champs, interrompaient par intervalle leurs travaux pour se demander ce que signifiait l'arrivée de ces nouvelles troupes. Malgré les vagues rumeurs qui leur étaient venues de divers côtés, ils ne soupçonnaient évidemment pas l'épouvantable catastrophe qui était sur le point de fondre sur eux. Dans quelques jours cependant, ce vallon si paisible et qui abritait tant de familles heureuses, allait devenir le coin le plus désolé du monde.

Winslow ne fit d'abord que jeter l'ancre devant Grand-Pré ; il remonta la rivière Pisiquid (aujourd'hui l'Avon), et débarqua ses troupes au village de Pisiquid où avait été bâti un fort en palissades nommé fort Edward, d'où le capitaine Murray avait l'œil sur la population environnante. Winslow fit dresser les tentes de ses soldats autour du fort, et passa quelques temps auprès de Murray pour concerter avec lui les moyens de préparer le piège qu'ils avaient à tendre, sans éveiller les soupçons des Acadiens ; puis il redescendit à Grand-Pré.

En l'absence du missionnaire, il fit venir quelques-uns des principaux paroissiens,

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[1] Things are now very heavy on my heart and hands.... I impatiently wait... that once at length we may get over this troublesome affair, which is more grevious to me than any service I was ever employed in. — *Journal of Winslow*, p. 97, 134.

Le commandant de Port-Royal, John Handfield, à qui Winslow écrivait ces dernières paroles, était poursuivi par le même sentiment de honte et lui répondait: " I Heartily join with you in wishing that we were both of us got over this most disagreable and troublesome part of the service. — *Journal de Winslow*, p. 142.

et leur enjoignit d'enlever les vases sacrés de l'église, car il voulait s'en servir pour faire son quartier général.[1] Cette profanation par laquelle Winslow inaugurait son arrivée était de sa part une imprudence de nature à trahir ses intentions hostiles, et qui aurait dû, ce semble, éveiller la méfiance des habitants. Ceux-ci cependant n'en furent guère émus, ce qui prouve bien ce que valait le régime de douceur dont se vantaient les autorités officielles en reprochant aux Acadiens de s'y être montrés ingrats.

Mais les Acadiens avaient fini par s'endurcir aux vexations et à s'endormir au bord de l'abîme. Ils avaient cru donner des preuves suffisantes de leur neutralité en livrant leurs armes. Ce fut leur dernière faute et la plus grande ; car elle les laissait à la merci de leurs ennemis. Ceux-ci n'eurent plus qu'à attendre une occasion favorable pour tendre leurs pièges et les y faire tomber. Elle était venue.

Winslow transforma l'église en arsenal et en salles d'armes, dressa les tentes de ses soldats sur la place publique, et s'établit lui-même dans le presbytère. Pour prévenir toute surprise, il fortifia son camp d'une enceinte de palissades, et il écrivit au gouverneur Lawrence, qui lui avait exprimé la crainte que les habitants en fussent alarmés : " Ces travaux ne leur ont pas causé la moindre inquiétude, car ils y ont vu la preuve que le détachement doit passer l'hiver au milieu d'eux."[2] Et Winslow concluait en disant que, les récoltes n'étant pas encore terminées, il était convenu avec Murray d'attendre jusqu'au vendredi suivant pour publier l'ordre du gouverneur.

Le 30 du mois, Murray, venu du fort Edward à Grand-Pré, s'enferma dans le presbytère avec Winslow pour conclure les derniers préparatifs. Il fut convenu que Winslow sommerait toute la population mâle des environs de Grand-Pré de venir le rencontrer à l'église pour entendre l'ordonnance du roi, et que Murray ferait de même à Pisiquid. Winslow fit alors entrer les officiers qu'il avait sous ses ordres, leur fit prêter serment de garder le secret, et leur communiqua ses instructions et ses plans. Aucun d'eux ne fit d'objection, et Murray reprit le chemin du fort Edward.

XI

Dans la journée du dimanche, le dernier que les pauvres Acadiens avaient à passer en paix au sein de leurs familles, Winslow eut la satisfaction d'observer qu'il n'y avait

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[1] Afin de priver les Acadiens de leurs conseillers les plus éclairés, et par là de mieux assurer le succès du complot, Lawrence avait donné ordre de s'emparer d'avance des missionnaires soit par la ruse, soit par la force ouverte. Les trois desservants de cette partie de la baie, MM. Chauvreulx, Daudin et Lemaire, avaient été arrêtés dès le milieu de juillet précédent, conduits à Halifax et détenus séparément sur la flotte de l'amiral Boscawen. Ils furent ensuite envoyés en Angleterre d'où ils passèrent en France.

Ces actes de violence n'avaient pas trop surpris leurs paroissiens, car ceux-ci étaient habitués à voir leurs prêtres en butte aux persécutions. Il faut bien avouer aussi que les Acadiens, aveuglés par tant d'intérêts qui les attachaient à leur pays, refusaient obstinément d'ouvrir les yeux à l'évidence. Ils avaient été inutilement avertis depuis longtemps. Le plus clairvoyant de leurs missionnaires surtout, l'abbé Leloutre, avait en vain accumulé sur sa tête toutes les colères et toutes les haines de leurs ennemis, en démasquant sans relâche leurs projets ; les prédictions de cette autre Cassandre n'avaient pas été plus écoutées que celles de la fatidique Troyenne. Simples et droits, les Acadiens étaient faciles à tromper ; leurs oppresseurs, plus perfides que les Grecs, le savaient, et ils ne reculaient devant aucune trahison pour y arriver. On verra par certaines citations qui vont suivre, dans quel réseau de mensonges les malheureuses victimes avaient été enveloppées.

[2] *Journal de Winslow*, p. 85.

aucun mouvement inusité dans le village. La seule contrariété qu'il éprouvât fut de voir que les moissons n'étaient pas encore toutes rentrées, et qu'une partie allait peut-être échapper à la destruction. Il avait pu le constater durant une tournée qu'il venait de faire dans le voisinage avec une cinquantaine de ses hommes.

Des croisées ouvertes du presbytère il était témoin ce jour-là d'une scène qui ne pouvait manquer de se graver dans sa mémoire, et qui lui revenait sans doute lorsqu'il traçait certains passages de son journal, où l'on devine les pensées troublantes qui l'obsédaient, comme ce qui suit, par exemple : " Nous aurons bientôt les mains pleines de l'affaire désagréable qui nous oblige à chasser un peuple de ses anciennes habitations, lesquelles dans cette partie du pays, ont une très grande valeur." [1]

C'est que, malgré lui, il établissait un contraste terrible entre la douce pastorale qu'il avait sous les yeux et les scènes de désespoir qu'il allait provoquer dans quelques jours. Ce contraste lui apparaissait d'autant plus violent qu'on était précisément à l'époque de l'année où le bassin des Mines offrait le coup d'œil le plus séduisant, et que, du point de vue où il était, il embrassait tout l'ensemble et les détails de ce charmant paysage avec le mouvement rural qui l'animait.

On se sentait au milieu d'une atmosphère de quiétude et de sérénité, dans cette solitude lointaine et ignorée du monde, autour de cette nappe d'eau, à peine moirée par la brise, abritée comme un lac, là-bas, par des hauteurs bleuissantes, plus près par le promontoire abrupt du cap Doré, ici par un cercle de pentes douces terminées par la Grand' Prée. On y entendait beugler les vaches qui remontaient vers les étables où les attendaient les laitières. Il n'y avait pas jusqu'au chant du grillon, caché dans l'herbe, qui ne rappelât le bonheur domestique.

Ce bonheur, il est vrai, n'avait pas atteint ce degré de perfection, cet idéal qu'ont voulu y voir certains auteurs qui en ont fait des tableaux de fantaisie : l'*Acadie* n'a jamais été l'*Arcadie*. Les Acadiens avaient leur part des misères et des défauts qui sont l'apanage de l'humanité. Un bon nombre d'entre eux étaient processifs comme les Normands leurs pères, jaloux les uns des autres, comme les Canadiens leurs frères. Ils n'étaient pas toujours dociles, obéissants à leurs missionnaires, comme l'ont supposé quelques auteurs aussi loin en cela de la vérité que les idéalistes qui les ont représentés comme des hommes parfaits ; mais, en général, ils étaient bons, affables et serviables. L'esprit français, toujours gai, toujours vif, prompt aux reparties, s'était conservé parmi eux, bien qu'ils n'eussent d'autre instruction que les solides principes du christianisme. Modérés dans leurs goûts, simples dans leurs habitudes, ils avaient peu de besoins, et ils étaient contents de leur sort. L'incomparable fertilité de leurs terres, moins difficiles à ouvrir et à cultiver que celles du Canada, leur donnait en peu d'années assez d'aisance pour établir leurs enfants autour d'eux, et pour jouir d'une vieillesse heureuse. Quant à leur moralité, elle n'a pas besoin d'autre preuve que l'étonnante fécondité des familles, qui n'a été égalée que par celle des pasteurs boers du Transvaal. [2]

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[1] Sh ll soon have our hands full of desagreable business to remove people from their ancient habitations which, in this part of the country, are very valuable. — *Journal de Winslow*, p. 72.

[2] Voici un témoignage non suspect de la pureté des mœurs et du caractère des Acadiens, écrit en 1791, par l'honorable Brook Watson, qui avait commandé le détachement envoyé à la baie Verte pour en enlever les habitants et brûler les maisons.

" C'était un peuple honnête, industrieux, sobre et vertueux ; rarement des querelles s'élevaient parmi eux. En été les hommes étaient constamment occupés à leurs fermes, en hiver ils coupaient du bois pour leur chauffage

La population de Grand-Pré était répandue par essaims dans le village, ou apparaissait aux fenêtres ouvertes et devant les portes des maisons. Çà et là s'élevaient des cris joyeux d'enfants attroupés sous les arbres des vergers chargés de fruits, ou des voix de femmes qui chantaient pour endormir leurs nouveaux-nés. Quelques vieillards, assis sur les clôtures, fumaient tranquillement leurs pipes en devisant du lendemain. Des groupes de garçons et de jeunes filles, vêtus de leurs habits du dimanche, passaient, en causant, aux abords de l'église : les jeunes gens habillés d'étoffe tissée à la maison ; les jeunes filles portant jupon et *mantelet*, coiffées de chapeaux de paille tressée de leurs mains. Bien des couples qui, en ce moment, se faisaient des aveux et formaient des projets d'union, étaient loin de se douter qu'ils étaient à la veille d'être séparés pour ne plus jamais se revoir.

XII

Dans la journée du mardi, Winslow prétexta une excursion en chaloupe du côté de Pisiquid, pour s'assurer auprès de Murray que rien n'y avait transpiré de leur guet-apens ; et ils s'entendirent pour faire aux deux endroits l'assemblée à trois heures de l'après-midi, le vendredi suivant. Ils rédigèrent ensuite la sommation aux habitants qu'ils firent traduire par un marchand de l'endroit nommé Beauchamp.

La voici :

" John Winslow, écuyer, lieutenant-colonel et commandant des troupes de Sa Majesté, à Grand-Pré, les Mines, la rivière aux Canards et les lieux adjacents.

" Aux habitants des districts sus-nommés, aussi bien aux anciens qu'aux jeunes gens et aux petits garçons.

" Comme Son Excellence le gouverneur nous a instruit de sa dernière résolution, concernant les matières proposées récemment aux habitants en général, en personne, Son Excellence désirant que chacun d'eux fût parfaitement informé des intentions de Sa Majesté qu'il nous a aussi ordonné de vous communiquer, telles qu'elles nous ont été données ;

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et leurs clôtures, et faisaient la chasse ; les femmes s'occupaient à carder, filer et tisser la laine, le lin et le chanvre que ce pays fournissait en abondance. Ces objets, avec les fourrures d'ours, de castor, de renard, de loutre et de martre, leur donnait non seulement le confort, mais bien souvent de jolis vêtements. Ils leur procuraient aussi les autres choses nécessaires ou utiles au moyen du commerce d'échange qu'ils entretenaient avec les Anglais et les Français. Il y avait peu de maisons où l'on ne trouvât pas une barrique de vin de France. Ils n'avaient d'autres teintures que le noir et le vert ; mais afin d'obtenir du rouge dont ils étaient remarquablement épris, ils se procuraient des étoffes rouges anglaises qu'ils coupaient, *échiffaient*, cardaient, filaient et tissaient en bandes dont étaient ornés les vêtements des femmes. Leur pays était tellement abondant en provisions que j'ai entendu dire qu'on achetait un bœuf pour cinquante chelins, un mouton pour cinq, et un minot de blé pour dix-huit deniers. On n'encourageait pas les jeunes gens à se marier à moins que la jeune fille ne pût tisser une mesure de drap, et que le jeune homme ne pût faire une paire de roues. Ces qualités étaient jugées essentielles pour leur établissement, et ils n'avaient guère besoin de plus, car chaque fois qu'il se faisait un mariage, tout le village s'employait à établir les nouveaux mariés. On leur bâtissait une maison, défrichait un morceau de terre suffisant pour leur entretien immédiat ; on leur fournissait des animaux et des volailles ; et la nature, soutenue par leur propre industrie, les mettait bientôt en moyen d'aider les autres. Je n'ai jamais entendu parler d'infidélité dans le mariage parmi eux. Leurs longs et froids hivers se passaient dans les plaisirs d'une joyeuse hospitalité. Comme ils avaient du bois en abondance, leurs maisons étaient toujours confortables. Les chansons rustiques et la danse étaient leur principal amusement." — *Collections of Nova Scotia Historical Society*, v. II, p. 132.

Voilà ce qu'avaient fait des Acadiens les prêtres dont on a cherché, de nos jours comme de leurs temps, à flétrir la mémoire. On juge de l'arbre par ses fruits.

" Nous ordonnons donc et enjoignons strictement par ces présentes à tous les habitants, aussi bien des districts sus-nommés que de tous les autres, aux vieillards de même qu'aux jeunes gens, et aussi à tous les garçons de dix ans, de venir à l'église de Grand-Pré vendredi, le cinq courant, à trois heures de l'après-midi, afin que nous leur fassions part de ce que nous avons reçu ordre de leur communiquer ; déclarant qu'aucune excuse ne sera admise sous aucun prétexte que ce soit, sous peine de confiscation de leurs biens meubles et immeubles.

" Donné à Grand-Pré, le deux septembre en la vingt-neuvième année du règne de Sa Majesté, A. D. 1755." [1]

Une proclamation semblable fut rédigée au nom de Murray pour les habitants du district de Pisiquid.

La veille de l'assemblée, les deux commandants dépêchèrent leurs officiers vers les principaux centres pour afficher cette proclamation. Ils trouvèrent partout les habitants sans défiance, occupés dans les champs à achever leurs récoltes.

Le lendemain, dès l'heure de midi, tout le détachement américain était sous les armes devant le portail de l'église de Grand-Pré, les fusils chargés, prêts à faire feu. Dans la matinée, une distribution de poudre et de balles avait été faite aux soldats.

Winslow, en grand uniforme, entouré de son état-major, stationnait devant le presbytère. Ses regards inquiets se tournaient souvent vers les différents chemins qui conduisaient à Grand-Pré, et il ne put réprimer sur ses traits l'expression de la joie secrète qu'il éprouva lorsqu'il les vit se peupler de longues files d'habitants, les uns à pied, venant des environs, les autres en voiture, arrivant des Mines, de Gaspareaux, de la rivière aux Canards et de l'intérieur des terres.

Winslow, dont le portrait a été conservé, n'avait pas la tournure d'un colon américain ; puissant de taille, il paraissait plutôt un gros Anglais, joufflu, rubicond, avec des yeux à fleur de tête, vrai type qui convenait à une pareille exécution.

A trois heures précises, quatre cent dix-huit Acadiens de tout âge étaient réunis dans l'église. Quand les derniers furent entrés, et les portes fermées et gardées, le commandant, accompagné de quelques officiers, vint se placer debout, dans le chœur, devant une table sur laquelle il posa ses instructions et l'adresse qu'il avait à lire.

Il promena un instant ses regards sur cette foule de figures hâlées par le soleil, qui le fixaient dans un anxieux silence ; puis il leur lut l'adresse suivante que traduisait à mesure un interprète :

" Messieurs, j'ai reçu de Son Excellence le gouverneur Lawrence les instructions du roi, que j'ai entre les mains. C'est par ses ordres que vous êtes assemblés, pour entendre la résolution finale de Sa Majesté concernant les habitants français de cette sienne province de la Nouvelle-Ecosse, où depuis près d'un demi-siècle vous avez été traités avec plus d'indulgence qu'aucuns autres de ses sujets dans aucune partie de ses Etats. Vous savez mieux que tout autre quel usage vous en avez fait.

" Le devoir que j'ai à remplir, quoique nécessaire, m'est très désagréable et contraire à ma nature et à mon caractère, car je sais qu'il doit vous être pénible étant de même sentiment que moi. Mais il ne m'appartient pas de m'élever contre les ordres que j'ai reçus ; je dois y obéir. Ainsi, sans autre hésitation, je vais vous faire connaître les instruc-

[1] *Journal de Winslow*, p. 90.

tions et les ordres de Sa Majesté, qui sont que vos terres et vos maisons, et votre bétail et vos troupeaux de toutes sortes sont confisqués par la couronne, avec tous vos autres effets, excepté votre argent et vos objets de ménage, et que vous-mêmes vous devez être transportés hors de cette province.

" Les ordres péremptoires de Sa Majesté sont que tous les habitants français de ces districts soient déportés ; et, grâce à la bonté de Sa Majesté, j'ai reçu l'ordre de vous accorder la liberté de prendre avec vous votre argent et autant de vos effets que vous pourrez emporter sans surcharger les navires qui doivent vous recevoir. Je ferai tout en mon pouvoir pour que ces effets soient laissés en votre possession et que vous ne soyez pas molestés en les emportant, et aussi que chaque famille soit réunie dans le même navire ; afin que cette déportation, qui, je le comprends, doit vous occasionner de grands ennuis, vous soit rendue aussi facile que le service de Sa Majesté peut le permettre ; j'espère que dans quelque partie du monde où le sort va vous jeter, vous serez des sujets fidèles, et un peuple paisible et heureux.

" Je dois aussi vous informer que c'est le plaisir de Sa Majesté que vous soyez retenus sous la garde et la direction des troupes que j'ai l'honneur de commander." [1]

Winslow termina son discours en les déclarant tous prisonniers du roi.

Il est plus facile d'imaginer que de peindre l'étonnement et la consternation des Acadiens en écoutant cette sentence. Ils comprirent alors que les vagues soupçons qu'ils avaient refusé d'entretenir étaient trop fondés ; et que cette assemblée n'avait été qu'un infâme piège où ils s'étaient laissé prendre. Cependant ils ne réalisèrent pas du premier coup, toute l'horreur de leur situation : ils se persuadèrent que l'on n'avait pas réellement l'intention de les déporter. Ils ne pouvaient se figurer qu'il eût pu se trouver un ministre anglais à Londres pour conseiller au roi d'Angleterre de tendre un tel piège et de signer un pareil arrêt. Et ils avaient raison : c'était un audacieux mensonge. Jamais pareil ordre n'était parti d'Angleterre. L'initiative en était due à Lawrence, poussé par ses subalternes anglo-américains, qui voulaient à tout prix assouvir leur haine contre les Acadiens.

La révélation de ce fait prendra par surprise bien des lecteurs accoutumés à croire le contraire ; cependant elle est appuyée sur les documents officiels les plus authentiques, sur les dépêches mêmes du ministre de Londres au gouverneur Lawrence en personne.

Après la prise de Beauséjour, celui-ci s'était empressé d'en annoncer la nouvelle en Angleterre, et, dans sa dépêche, il insinuait en termes assez vagues son projet de déporter les Acadiens en masse.

Le secrétaire d'Etat, sir Thomas Robinson, ne comprit pas toute la portée de ses paroles, mais il en fut alarmé, et il se hâta de lui répondre : " On ne voit pas clairement si vous avez intention d'enlever tous les habitants français de la péninsule... ou bien si vous entendez parler seulement de ceux des habitants trouvés à Beauséjour, quand ce fort a été évacué par la garnison.... Quelle que soit votre intention, il n'y a pas de doute... que vous avez considéré les conséquences pernicieuses qui pourraient résulter d'une alarme qui aurait pu être donnée à tout le corps des Français neutres, qu'une insurrection soudaine pourrait être le résultat du désespoir, et aussi quel nombre additionnel de sujets utiles pourrait être donné, par leur fuite, au roi de France. Par conséquent il ne peut trop vous

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[1] *Journal de Winslow*, p. 94.

être recommandé d'user de la plus grande précaution et de la plus grande prudence dans votre conduite vis-à-vis ces *neutres*, et d'assurer ceux d'entre eux en qui vous pouvez avoir confiance, particulièrement lorsqu'ils prêteront serment à Sa Majesté et à son gouvernement, QU'ILS PEUVENT DEMEURER DANS LA TRANQUILLE POSSESSION DE LEURS TERRES, sous une législation convenable." [2]

Cette réponse est en date du 13 août 1755, c'est-à-dire précisément au moment où Lawrence mettait à exécution son complot et déchaînait ses limiers américains.

On voit maintenant sur qui retombe la responsibilité de la déportation des Acadiens. Le cabinet de Londres y fut complètement étranger ; il recommandait à ce moment-là même, avec la plus vive instance, les mesures de paix et de conciliation. Cette déportation fut due au zèle indiscret de ses représentants en Amérique qui, obsédés sans cesse par leurs entourages, fléchirent devant leur fanatisme, et, disons-le aussi, devant leur frayeur.

Il n'y a pas un mot dans cette dépêche qui ne soit une contradiction de la conduite de Lawrence. Ce fait est si remarquable que nous croyons devoir nous arrêter un instant à étudier cette dépêche pour mieux faire ressortir cette contradiction.

Et d'abord, elle dévoile que Lawrence avait dissimulé son projet de bannissement général : " Il paraît, dit-elle, par votre lettre du 28 juin, que vous avez donné des ordres au colonel Monckton *de chasser en tous cas, hors du pays, les habitants français désertés* (*de leurs terres*). On ne voit pas clairement, ajoute la dépêche, si vous avez intention d'enlever tous les habitants français de la péninsule, dont le nombre s'élève à plusieurs mille... ou bien si vous entendez parler seulement de ceux des habitants trouvés à Beauséjour, quand ce fort a été évacué par la garnison ; ce dernier projet paraît plutôt avoir été votre intention, puisque vous ajoutez, *que si M. Monckton désire l'assistance des habitants français désertés, pour mettre les troupes à l'abri, vu que les casernes du fort français ont été démolies, il pourrait leur faire faire tout le service en leur pouvoir.*"

N'est-il pas manifeste, d'après ce passage, que Lawrence avait dissimulé son plan dans sa lettre ?

Ensuite quelle ligne de conduite lui trace le secrétaire d'Etat ? Sont-ce les mesures d'intimidation et de rigueur qu'il lui conseille ? Tout au contraire, il lui impose le plus strict devoir (*it cannot be too much recommended to you*) d'agir avec la plus grande précaution et une extrême prudence, non seulement pour ne pas alarmer les Acadiens et exposer l'Angleterre à perdre, par leur fuite, ces sujets utiles ; mais de plus il lui enjoint de les rassurer, particulièrement ceux qui viendront prêter serment d'allégeance, et de leur garantir la tranquille possession de leurs terres. " Ce qui m'a engagé à attirer votre attention toute particulière sur cette partie de votre lettre, ajoutait sir Thomas Robinson, qui évidemment redoutait les violences de Lawrence, c'est la proposition qui m'a été faite, pas plus tard qu'au mois de mai dernier, par l'ambassadeur de France, savoir : " Qu'il soit " accordé trois ans aux habitants français de la péninsule pour s'en retirer avec leurs effets, " et que tous les moyens de faciliter ce transport leur soient aussi accordés. Les Anglais, " ajoutait l'ambassadeur, devraient regarder sans nul doute cette proposition comme très " avantageuse pour eux." A quoi il a plu à Sa Majesté de faire la réponse suivante que je vous envoie pour votre particulière information, savoir : " Qu'en ce qui regarde la proposi- " tion d'accorder trois ans aux habitants français de la péninsule pour émigrer, ce serait

[2] *Archives de la Nouvelle-Ecosse*, p. 279.

" priver la Grande-Bretagne d'un nombre très considérable de sujets utiles, si une telle " émigration s'étendait aux Français qui habitaient cette province au temps du traité " d'Utrecht et à leurs descendants."

Voilà quelles étaient les instructions émanées du cabinet de Londres. Il n'y a pas à se méprendre sur l'esprit qui les avait dictées : c'était un esprit d'apaisement et de pacification.

On reste épouvanté quand on les compare avec la conduite tenue par Lawrence. Où étaient, de sa part, les mesures de précaution et d'extrême prudence pour ne pas alarmer ces *sujets utiles ?*

N'avait-il pas, au contraire, fait tout en son pouvoir pour les pousser à ce désespoir dont le secrétaire d'Etat lui marquait les pernicieuses conséquences ? Toutes leurs armes leur avaient été confisquées et jusqu'à leurs canots de pêche et toutes leurs autres embarcations. Quand leurs députés étaient venus à Halifax, dans le cours de l'été, pour supplier Lawrence de leur restituer ces objets, ils les avait accablés de reproches et de menaces en refusant de les leur rendre.[1] Est-il étonnant qu'après de pareils traitements, ils aient été effrayés de prêter le serment sans réserve qu'il exigeait d'eux avec la rigueur d'un proconsul romain ? Et ce qu'il y a de plus incroyable, c'est qu'après toutes ces intimidations, lorsque ceux d'entre eux qui se décidèrent enfin à prêter ce serment si redoutable à leurs yeux, se présentèrent devant Lawrence, celui-ci, au lieu de les accueillir *avec une extrême précaution et prudence, et de leur assurer la tranquille possession de leurs terres*, les repoussa avec hauteur en leur disant "qu'il était trop tard ; et que désormais ils seraient traités comme des récusants papistes " et il les fit mettre en prison.[2]

Nous le demandons : qu'y a-t-il de commun entre cette conduite barbare et les instructions du cabinet de Londres ? N'est-il pas évident qu'il y avait chez Lawrence une détermination bien arrêtée de se débarrasser à tout prix des Acadiens, *ces ennemis invétérés de notre religion*, comme écrivait le même Lawrence dans la dépêche où il annonçait leur déportation.[3]

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[1] *Archives de la Nouvelle-Ecosse*, p. 247 et suivantes. [2] *Idem*, p. 256. [3] *Idem*, p. 281.

Lawrence savait très bien qu'il n'avait pas le droit de présumer de la volonté du gouvernement anglais. Il n'avait qu'à ouvrir les dépêches adressées depuis longtemps à ses prédécesseurs pour lire les ordres les plus formels à cet égard, comme celui-ci par exemple :

" ....You are not to attempt their removal without His Majesty's positive order." — *Archives de la Nouvelle-Ecosse*, p. 58. Et cette recommandation à lord Cornwallis : " ....We doubt not but that you will continue using all possible means that may prevent the French inhabitants retiring from the province." — *Id.*, p. 611.

Le cabinet de Londres n'avait pas osé signer l'ordre d'expulsion, parce qu'il se rappelait que la position fausse faite aux Acadiens était due à son attitude et à celle de ses agents vis-à-vis d'eux, surtout au serment de neutralité que des gouverneurs leur avaient permis de prêter. L'honneur de l'Angleterre était engagé dans ce dilemme : ou protéger les Acadiens, ou les laisser partir librement.

Ceux qui veulent étudier cette question au point de vue légal peuvent consulter une savante dissertation publiée sur ce sujet par un historiographe américain. Il démontre que les Acadiens furent bannis, non pas pour délit politique, mais à cause de leur religion, et qu'on ne prit pas la peine d'observer les formalités les plus élémentaires de la loi.

Nous en extrayons le passage suivant :

" Supposing, now, that the English laws against Popish Recusants applied to the inhabitants of the British Colonies — a point which is surely not very certain and though maintained by a New England Winslow in 1755, would have been gravely questioned by a New England Adams in 1775 — we come to consider what recusancy was, and what the penalties for recusancy were.

" The recusancy had to be established by indictment and trial. A person could be convicted only " upon

Ah ! s'il y avait eu à Halifax un vrai représentant du cabinet de Londres, les Acadiens n'auraient pas été bannis, et cette tache n'aurait pas été infligée à la civilisation.

Les événements de la guerre, qui se précipitèrent durant les années suivantes, détournèrent l'attention des ministres anglais, et leur firent accepter les faits accomplis.[1]

XIII.

Quand, après la fameuse assemblée du 5 septembre, les prisonniers acadiens virent Winslow sortir de l'église, quelques-uns des plus âgés le suivirent au presbytère et le conjurèrent de leur permettre d'aller avertir leurs familles de ce qui venait de se passer, de crainte qu'elles ne prissent trop d'inquiétude. Après s'être consulté avec ses officiers, il consentit à laisser sortir chaque jour vingt des prisonniers, mais à la condition que les autres répondraient de leur retour. Chaque famille devait être enjointe d'apporter des vivres pour ceux des siens qui étaient détenus.

Murray écrivit le même jour à Winslow qu'il avait réussi à s'emparer de cent quatre-vingt trois hommes ; et tous deux se félicitèrent de leur succès. Mais leur joie fut tempérée par les nouvelles qu'ils reçurent de Port-Royal et de Chipoudy.

" indictment at the King's suit or a regular action or information on the statute of 23 Eliz. I, or an action of debt " at the King's suit alone, according to the statute of 35 Eliz. I." * Fines were imposed for recusancy, and if these were not paid the crown was empowered, " by process out of the exchequer, to take, seize and enjoy all the goods, " and two parts as well of all the lands, tenements and hereditaments, leases and farms, of such offender... leaving " the third part only of the same lands, tenements and hereditaments, leases and farms, to and for the maintain- " ance and relief of the same offender, his wife, children and family."

The severe acts of even Queen Elizabeth went no further. There was no provision by which the wife and children were punished for the offence of the father, nor was he deprived of all his lands. And even on conviction of recusancy, new proceedings were required before the crown could occupy the lands. " But as to lands and " tenements," says Cowley, " there must first be an office found for the kind; for regularly before the finding of " such office, lands or tenements cannot be seized into the King's hands." † The recusant was regarded as a tenant for life, even of the two-thirds, which went to the heir in remainder. The laws did not confiscate the lands absolutely ; and these laws gave no authority whatever to any officer to seize the recusant and his whole family and carry them off.

" There was no warrant whatever in English law for proceeding against Popish Recusants in the manner in which Lawrence and his Council did. And if there were individuals who were guilty of over acts of treason, they had power to punish them, but no law of Enland authorized the seizure of property of a whole community and the removal of their persons." — *The American Catholic Quarterly Review*, October, 1884. *The Acadian Confessors of the Faith*, 1755, p. 596.

* *Cowley's laws as concerning Jesuits, Seminary Priest, Recusants, etc., and concerning the oaths of supremacy and allegiance*, p. 252.

† *Cowley's Laws*, p. 104.

[1] Certains historiens ont avancé qu'on n'avait eu recours à la déportation qu'après avoir épuisé tous les moyens de douceur. Le cabinet anglais était loin, comme le prouve la dépêche de sir Thomas Robinson, d'être de ce sentiment.

Au reste, la persécution religieuse plus ou moins sourde qu'avaient eue à subir les Acadiens, et dont nous avons cité quelques exemples, mitige singulièrement ce prétendu régime de douceur. Nous pourrions au besoin multiplier ces exemples.

Les habitants de Port-Royal avaient eu vent de la conspiration, et s'étaient enfuis dans les bois ; un petit nombre seulement avaient été saisis. [1]

On a vu ce qui s'était passé à Chipoudy. Le major Frye en était encore tout consterné, le jour où il fit son rapport à Winslow. Et l'un de ses officiers ajoutait en le confirmant : " Tout notre monde ici est dans la crainte que vous, qui êtes au cœur de cette nombreuse engeance démoniaque, n'éprouviez le même sort, ce dont je prie Dieu qu'il vous préserve." [2]

Ces fâcheuses nouvelles firent craindre un soulèvement parmi les prisonniers. Il est probable qu'ils en cherchèrent l'occasion, et qu'ils s'y seraient déterminés, s'ils n'avaient pas conservé quelque illusion sur le sort qu'on leur réservait. C'est ce que firent plus tard une bande d'entre eux à bord d'un des vaisseaux, dont ils s'emparèrent.

Les jours qui suivirent l'assemblée, des patrouilles furent envoyées dans les différentes directions pour saisir ceux qui avaient échappé à la première arrestation. Les soldats tiraient sans pitié sur tous ceux qui cherchaient à fuir. Un habitant du nom de Melançon, paraît-il, ayant aperçu une des patrouilles dans le voisinage de sa maison, s'était élancé sur un de ses chevaux pour gagner le bois ; mais une balle était venue l'atteindre et le jeter mort sur la route. Plusieurs autres eurent le même sort. Bientôt l'église de Grand-Pré, qui avait été convertie en prison, fut encombrée de près de cinq cents des malheureux Acadiens.

L'enceinte palissadée servait de préau, où, durant le jour, un certain nombre avaient la permission d'errer à tour de rôle, sous l'œil des sentinelles, qui avaient ordre de tirer sur quiconque ferait mine de vouloir s'évader.

On ne peut lire sans attendrissement la requête que les Acadiens présentèrent à Winslow, peu de jours après leur détention.

Il est de mode parmi leurs adversaires de les qualifier d'ignorants, d'hommes inférieurs, dénués de sentiments élevés. On va voir par cette requête admirable dans sa simplicité, quelle distance il y avait entre eux et leurs bourreaux.

" A la vue, disaient-ils, des maux qui semblent nous menacer de tous côtés, nous sommes obligés de réclamer votre protection et de vous prier d'intercéder auprès de Sa Majesté, afin qu'elle ait égard à ceux d'entre nous qui ont inviolablement gardé la fidélité et la soumission promises à Sa Majesté ; et, comme vous nous avez donné à entendre que le roi a ordonné de nous transporter hors de cette province, nous supplions que, s'il nous faut abandonner nos propriétés, il nous soit au moins permis d'aller dans les endroits où nous trouverons des compatriotes, le tout à nos propres frais ; et qu'il nous soit accordé

[1] Le passage suivant d'une lettre de M. l'abbé LeGuerne, qui, comme on le sait, était missionnaire de Memramcook, Peticoudiac et Chipoudy, révèle quelque chose des moyens perfides qu'on avait employés pour attirer les Acadiens.

...." Il n'est point de trahisons dont l'Anglais ne se soit servi contre l'habitant, soit pour l'emmener, soit pour sonder ses intentions.... C'étaient des espérances des plus flatteuses... la paix ramènerait un chacun sur son ancienne habitation....

.... Le commandant anglais par ses promesses séduisantes, des offres captieuses, et par des présents même... avait cru me mettre dans ses intérêts. Se croyant donc assuré de moi, il me manda qu'il souhaitait de me voir incessamment. Je me gardai bien des embûches qu'il me tendait ; à une lettre où il me pressait encore de bannir toute defiance et de me rendre au fort (Beauséjour), je répondis que je me souvenais que M. Maillard avait été embarqué malgré une assurance positive d'un gouverneur anglais, et que j'estimais mieux me retirer que de m'exposer en aucune manière." — 10 mars, 1756.

[2] *Journal de Winslow*, p. 102.

un temps convenable pour cela, d'autant plus que par ce moyen nous pourrons conserver notre religion que nous avons profondément à cœur, et pour laquelle nous sommes contents de sacrifier nos biens." [1]

Winslow, qui a couché cette requête dans son journal, n'a pas même soupçonné la sublimité des sentiments qu'elle exprimait. Après l'avoir transcrite, il passe à l'ordre du jour sans ajouter un mot.

Winslow était également resté sourd à toutes les supplications des femmes et des enfants. Voyant les plus hardis s'indigner ouvertement et se concerter ensemble, il craignit qu'ils ne vinssent à se porter à quelque acte de désespoir, et, sur l'avis de ses officiers, il résolut de profiter de l'arrivée de cinq vaisseaux de Boston qui venaient d'ancrer à l'embouchure de la rivière Gaspareaux, pour faire monter sur chacun d'eux cinquante des captifs.

Dans la matinée du 10 septembre, la garnison fut appelée sous les armes, et placée derrière le presbytère en colonnes adossées à l'un des longs pans de l'église qui faisait face aux deux portes de l'enceinte palissadée. Winslow fit alors venir celui des anciens, connu sous le nom de *père* Landry, qui, sachant le mieux l'anglais, servait ordinairement d'interprète, et il lui dit d'avertir les siens que deux cent cinquante d'entre eux seraient embarqués immédiatement, et qu'on commencerait par les jeunes gens, qu'ils n'avaient qu'une heure de délai pour se préparer, parce que la marée était sur le point de baisser. " Landry fut extrêmement surpris, ajoute Winslow ; mais je lui dis qu'il fallait que la chose fût faite, et que j'allais donner mes ordres." [2]

Les prisonniers furent amenés devant la garnison, et mis en lignes, six hommes de front. Alors les officiers firent sortir des rangs tous les jeunes gens non mariés au nombre de cent quarante et un, et, après les avoir mis par ordre, ils les firent envelopper par quatre-vingts soldats détachés de la garnison sous le commandement du capitaine Adams.

Jusqu'à ce moment tous ces malheureux s'étaient soumis sans résistance ; mais, quand on voulut leur ordonner de marcher vers le rivage pour y être embarqués, ils se récrièrent et refusèrent d'obeir. On eut beau les commander et les menacer, tous s'obstinèrent dans leur révolte avec des cris et une agitation extrêmes, disant avec raison que, par ce procédé barbare, on séparait le fils du père, le frère du frère. Ce fut là le commencement de cette dislocation des familles, qui n'a pas d'excuse, et qui a marqué d'une tache ineffaçable le nom de ses auteurs.

Quand on sait qu'une partie de ces jeunes gens n'étaient que des enfants de dix à douze ans, et par conséquent bien moins redoutables que des hommes mariés dans la force de l'âge et qui avaient de plus grands intérêts à sauvegarder, on ne peut comprendre ce raffinement de cruauté.

Il faut laisser Winslow lui-même raconter cet incident : " J'ordonnai aux prisonniers de marcher. Tous répondirent qu'ils ne partiraient pas sans *leurs pères. Je leur dis que c'était une parole que je ne comprenais pas*, car le commandement du roi était pour moi absolu et devait être obéi absolument, et que je n'aimais pas les mesures de rigueur, mais

[1] *Journal de Winslow*, p. 112.

On ne dira pas que c'étaient les prêtres qui avaient dicté cette requête aux Acadiens ; il n'y en avait pas dans les environs. MM. Chauvreulx, Daulin, LeMaire et Maillard avaient été faits prisonniers ; LeGuerne était fugitif, avec la plupart de ses paroissiens, vers le fond de la baie ; et Desenclaves, avec les siens, du côté du Cap-Sable.

[2] *Journal de Winslow*, p. 109.

que le temps n'admettait pas de pourparlers ou de délais, alors j'ordonnai à toutes les troupes de charger à la baïonnette et de s'avancer sur les Français. Je commandai moi-même aux quatre rangées de droite des prisonniers, composées de vingt-quatre hommes, de se séparer du reste ; je saisis l'un d'entre eux qui empêchait les autres d'avancer, et je lui ordonnai de marcher. Il obéit."[1] Le reste des jeunes gens se résignèrent à suivre, mais non sans résistance, et avec des lamentations qui firent mal à Winslow lui-même. Une foule de femmes et d'enfants, parmi lesquels se trouvaient les mères, les sœurs, les fiancées de ces infortunés, étaient témoins de cette scène déchirante et en augmentaient la confusion par leurs gémissements et leurs supplications.

De l'église au lieu de l'embarquement la distance n'est pas moins d'un mille et demi. Elles s'attachèrent à leurs pas pendant tout ce trajet, en priant, pleurant, s'agenouillant, leur faisant des adieux, essayant de les saisir par leurs vêtements pour les embrasser une dernière fois.

Une autre escouade, composée de cent hommes mariés, fut embarquée aussitôt après la première, au milieu des mêmes scènes. Des pères s'informaient de leurs femmes restées sur le rivage où étaient leurs fils, des frères, où étaient leurs frères, qui venaient d'être conduits dans les navires ; et ils suppliaient les officiers de les réunir. Pour toute réponse, les soldats pointaient leurs baïonnettes et les poussaient dans les chaloupes.

Chaque famille eut ordre de nourrir les siens à bord, comme elle avait fait à l'église.

XIV

En lisant les instructions de Lawrence, on est naturellement porté à croire qu'il ait au moins recommandé de ne pas séparer les membres d'une même famille en les déportant ; mais il n'en est nullement question, pas plus que dans les rapports que lui adressait Winslow.[2]

Lawrence avait d'autres préoccupations : une de celles qu'il avait le plus à cœur, était de se faire choisir les plus beaux chevaux dans les écuries des Acadiens. Il avait

[1] ...." Order ye prisoners to march. They all answered they would not go without their fathers. I told them that was a word I did not understand, for that the King's command was to me absolute and should be absolutely obeyed and that I did not love to use harsh means, but that the time did not admit of parlies or delays, and then ordered the whole troops to fix their bayonets and advance towards the French, and bid the 4 right-hand files of the prisoners consisting of 24 men, which I told of myself to devied from the rest, one of whom I took hold (two opposed the marching) and bid march : he obeyed and the rest followed, though slowly, and went of praying, singing, and crying, being met by the women and children all the way (which is 1½ mile) with great lamentations upon their knees, praying, &c. — *Journal de Winslow*, p. 109. On a conservé l'orthographe de l'auteur.

[2] Dans le mémoire secret adressé par Lawrence à Murray, on lit le passage suivant qui n'a pas besoin de commentaires :

"Take an opportunity of acquainting the inhabitants that if any attempt by indians or others to Destroye or otherwise Molest his Majestys Troops, you have my orders to take an Eye for an Eye, a Tooth for a Tooth and in Shorte Life for Life from the nearest Nighbours where such Mischiefe is Performed."

"Choisissez une occasion pour prévenir les habitants que s'il se fait aucune tentative de la part des sauvages ou autres pour détruire ou molester de quelque manière les troupes de Sa Majesté, vous avez mes ordres de prendre œil pour œil, dent pour dent, en un mot vie pour vie sur les plus proches voisins du lieu où s'accomplira tel méfait."

donné tout exprès, pour cela, un sauf-conduit à un nommé Moïse LesDerniers qui fit une levée dans les différentes paroisses.[1]

Murray, que Lawrence avait chargé de lui rendre le même service, écrivait à Winslow : "J'ai vu plusieurs chevaux, mais je n'en ai trouvé aucun qui, je pense, puisse lui plaire, je suis informé aujourd'hui qu'il y a un cheval noir appartenant à un nommé Amand Gros, de Grand-Pré, qui, me dit-on, sera un cheval de selle qui conviendra à son goût. Je désire donc que vous soyez assez bon que d'ordonner à René Leblanc, fils, ou à quelques autres Français, de s'en emparer et de me l'amener.[2]

Winslow espérait que les transports destinés à recevoir toute la population ne tarderaient pas à arriver ; mais il fut trompé dans son attente. Sept de ces transports, expédiés de Port-Royal, n'entrèrent dans le bassin des Mines qu'aux premiers jours d'octobre.

Quelle que fût la dureté de Winslow pour les habitants de Grand-Pré, elle n'était rien comparée à celle que Murray montra à Pisiquid. Elle n'était rien surtout comparée à la brutalité des soldats anglo-américains qu'inspiraient une haine invétérée et des luttes sanglantes contre les Acadiens. Winslow finit par en être indigné, et ces désordres allèrent si loin qu'il dût publier un ordre du jour défendant, sous peine de châtiment sommaire, à tous soldats et matelots de quitter leurs quartiers, afin, disait-il, de mettre fin aux détresses d'un peuple en détresse.[3]

Trois des transports furent détachés du convoi et envoyés à Pisiquid, où, depuis des semaines, Murray les attendait avec impatience. Dans la lettre qu'il écrivait à Winslow pour lui annoncer leur arrivée, se trouve un passage où d'un trait il se peint lui-même : "Aussitôt que j'aurai dépêché mes vauriens (*my rascals*) je descendrai pour arranger nos affaires et me reposer un peu avec vous."[4]

Il écrivait quelques jours auparavant : "J'ai hâte de voir embarquer ces pauvres misérables.... Alors je me donnerai le plaisir de vous rencontrer et de boire à leur bon voyage.[5]

Dès que tout fut préparé pour le départ, le commandant fit une proclamation ordonnant aux habitants de se tenir prêts pour le huit octobre. Winslow avait annoncé dans l'assemblée du cinq septembre que les familles ne seraient pas divisées et que les habitants de chaque village seraient, autant que possible, embarqués sur les mêmes navires. On a vu, par ce qui s'était passé lors du premier embarquement, ce que valaient ces promesses. Au reste, nous avons sous la main une masse de faits, recueillis parmi les descendants des Acadiens, qui prouvent que le nombre des familles démembrées fut considérable.

Tel était l'attachement de ces pauvres gens pour leur pays, que, malgré les déclara-

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[1] Permit the Bearer Moses LesDerniers to go to Grand-Pré, to the Rivers Cannard and Habitant to look for some horses for the use of the lieutenant governor and bring the same to this Fort.

Fort Edward 3rd september 1755. A Murray, to all concerned.

The number of horses mentioned above are six. A. M.

Autre sauf-conduit au même par Winslow, 4 septembre. — *Journal de Winslow*, p. 91-93.

Cette date du 4 septembre est à remarquer : c'était la veille de l'assemblée où tous les biens des Acadiens allaient être confisqués au profit de la couronne. Lawrence n'avait pas voulu perdre l'occasion d'être le premier à mettre la main impunément sur ce qu'il y trouvait de plus précieux. On saisit ici sur le fait l'esprit qui animait l'organisateur de l'expédition : on connaît celui des subalternes.

[2] *Journal de Winslow*, p. 108.

[3] *Idem*, p. 113.

[4] *Idem*, p. 171.

[5] *Idem*, p. 108.

tions les plus formelles, réitérées durant tout un mois, ils s'obstinaient encore à se faire illusion, et gardaient quelque espoir de n'être pas déportés. Ce ne fut qu'au dernier moment qu'ils ouvrirent les yeux.

Il faut renoncer à décrire les scènes de cette lamentable journée du 8 octobre. On a peine à entendre même les récits imparfaits qu'en font aujourd'hui les petits-fils des exilés. C'est cette journée du 8 octobre qui leur est restée dans l'esprit, quand ils parlent parlent de *l'année du grand dérangement.*

Dès le matin de ce jour, des foules de femmes et d'enfants, venues de toutes les directions, depuis la rivière Gaspareaux jusqu'à Grand-Pré, des vieillards décrépits, des malades, des infirmes, traînés dans des charrettes encombrées d'effets de ménage, des mères portant leurs nouveaux-nés dans leurs bras, étaient poussés vers la Grand'Prée par des escouades de soldats sans pitié. Le chemin qui conduisait à travers cette grande plaine jusqu'au bord de la digue où se faisait l'embarquement, fut bientôt tout grouillant de cette masse d'êtres faibles et désespérés qui avaient peine à se mouvoir au milieu du tumulte et de la confusion générale. Des invalides, de faibles femmes chargées de fardeaux, tombaient de fatigue le long de la route, et ne se relevaient que sous les menaces ou devant les baïonnettes. Les uns s'avançaient mornes et silencieux, comme frappés de stupeur, les autres en pleurant et en gémissant ; quelques-uns en proférant des malédictions ; d'autres enfin, pris d'une exaltation pieuse, murmuraient des cantiques, à l'exemple des martyrs.[1] Les cris des enfants effrayés qu'on entendait de tous côtés se mêlaient aux aboiements d'une multitude de chiens qui rôdaient autour de cette foule en cherchant leurs maîtres.

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[1] Voici quelques fragments de cantiques que chantaient alors les Acadiens, et qu'on a retrouvés écrits sur des feuilles volantes, qu'ils emportaient parmi leurs objets les plus précieux. Une de ces feuilles se conserve au *British Museum* de Londres :

I

Faux plaisirs, vains honneurs, biens frivoles,
Ecoutez aujourd'hui nos adieux.
Trop longtemps vous fûtes nos idoles ;
Trop longtemps vous charmâtes nos yeux.
Loin de nous la futile espérance
De trouver en vous notre bonheur !
Avec vous heureux en apparence,
Nous portons le chagrin dans le cœur.

II

Vive Jésus !
Vive Jésus !
Avec la croix, son cher partage.
Vive Jésus,
Dans les cœurs de tous les élus !
Portons la croix,
....
Sans choix, sans ennui, sans murmure
Portons la croix !
Quoique très amère et très dure,
Malgré les sens et la nature
Portons la croix !

Mais ce fut au bord de la grève, à l'heure de l'embarquement, que la confusion fut extrême et que se passèrent les scènes les plus désolantes. Tous ces malheureux furent entassés pêle-mêle dans les chaloupes, malgré leurs plaintes, que la plupart des équipages ne comprenaient même pas, ne sachant pas leur langue ; et l'on ne prit pas plus de soin pour faire monter les membres de chaque famille dans les mêmes transports qu'on en avait mis lors de l'embarquement des jeunes gens. Aussi est-ce en ce moment, d'après la tradition, qu'eut lieu le plus grand nombre de séparations.[1]

Pour comble de malheur, Winslow se trouva ce jour-là dans une disposition d'esprit qui fit taire en lui le peu de sentiment humain qu'il avait pu montrer jusque-là. La veille de l'embarquement, vingt-quatre des prisonniers, profitant de l'obscurité de la nuit augmentée par la pluie, s'étaient échappés d'un des transports sans que les huit sentinelles de garde, ni les hommes de l'équipage, eussent pu lui en rendre compte.

En apprenant cette nouvelle le matin même de l'embarquement, Winslow tomba dans un état d'exaspération dont lui-même donne la mesure dans le passage suivant de son journal : " Je fis faire l'enquête la plus stricte qu'il me fut possible pour savoir comment ces jeunes gens s'étaient échappés hier, et d'après toutes les circonstances, je reconnus que c'était un nommé François Hébert qui se trouvait à bord du navire et y embarquait ce jour-là ses effets, qui en avait été l'auteur ou l'instigateur. Je le fis venir à terre, le conduisis devant sa propre maison, et alors, en sa présence, je fis brûler sa maison et sa grange, et je donnai avis à tous les Français que, dans le cas où ces hommes ne se rendraient pas d'ici à deux jours, je servirais tous leurs amis de la même manière ; et non seulement cela, mais que je confisquerais tous leurs biens de ménage, et que si jamais ces hommes tombaient entre les mains des Anglais, il ne leur serait accordé aucun quartier."[2]

Quand le soleil jeta ses derniers rayons sur le bassin des Mines une partie de la population était rendue à bord des navires. Cinq autres transports, arrivés les jours suivants, enlevèrent le reste. Cette chasse à l'homme s'était poursuivie avec une atroce activité sur tout le littoral de la baie de Fundy. Dans les environs de Beauséjour, Monkton en avait capturé et expédié au-delà d'un mille ; Murray, onze cents à Pisiquid ; Winslow, deux mille cinq cent dix, dans des vaisseaux effroyablement chargés ;[3] enfin Handfield, seize cent soixante-quatre dans la baie de Port-Royal.

Les débris de la population qui avaient échappé aux recherches, avaient pris la fuite dans les bois. Le nombre total des déportés acadiens dépassait le chiffre de six mille,[4] sur une population entière d'environ quatorze mille habitants.

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[1] De l'autre côté de la baie, dans les seules missions de Memramcook, de Peticoudiac et de Chipoudy, soixante femmes avaient été séparées de leurs maris, jetées de force dans les navires. — *Lettre de l'abbé LeGuerne à M. Prévost*, 10 mars 1756. Plusieurs de ces mères avaient des garçons qui leur avaient aussi été enlevés.

Il était souvent arrivé que des prisonniers avaient fait dire à leur famille de ne pas venir se rendre, dans l'espérance où ils étaient d'être rapatriés après la guerre.

[2] .... Made the strictest enquiry I could how these young men made their escape yesterday, and by every circumstance found one Francis Hebert was either the contriver or abetter who was on Board Church and this day his effects shipt, who I ordered a shore, carryd to his own house and then in his presence burnt both his house and barne, and gave notice to all the French that in case these men did not surrender themselves in two days, I should serve all their friends in the same manner and not only so would confiscate their household goods and when ever those men should fall into the english hands, they would not be admitted to quarter. — *Journal de Winslow*, p. 166.

[3] I put in more than two to a tun, and the people greatly crowded. — *Journal de Winslow*, p. 179.

[4] Haliburton porte ce chiffre à 7 ou 8,000.

Dans le Bassin des Mines, les transports, chargés de leur cargaison humaine, n'attendirent qu'un bon vent pour lever leurs ancres et cingler hors de la rade. Winslow eut un moment d'orgueilleuse satisfaction quand il les vit déployer leurs voiles et doubler, l'un après l'autre, le cap Blomedon. Il avait réussi au-delà de ses espérances. Toute cette vaste baie, où travaillait, comme un essaim d'abeilles, un peuple industrieux, était maintenant déserte. Dans les villages silencieux, où les portes et les fenêtres des maisons battaient au vent, on n'entendait plus que les pas de ses soldats et les mugissements des troupeaux qui erraient inquiets autour des étables, comme pour chercher leurs maîtres.

D'après les ordres qu'il avait reçus du gouverneur Lawrence, toutes les constructions devaient être détruites, afin que les habitants échappés aux poursuites, privés d'asiles, fussent forcés de se rendre.

Les derniers navires qui emportaient les exilés n'avaient pas encore franchi l'entrée du bassin des Mines, quand ces infortunés, qui jetaient un regard d'adieu sur leur cher pays, aperçurent des nuages de fumée qui montait du toit des maisons. En quelques instants, toute la côte, depuis Gaspareaux jusqu'à Grand-Pré, fut en flamme, car les granges et les étables, toutes pleines de foin et de gerbes,[1] prirent feu comme des traînées de poudre. Un cri de douleur s'échappa de toutes les poitrines.

Mais ce fut surtout lorsque les Acadiens virent brûler la jolie église de la rivière aux Canards, dont l'incendie leur faisait voir clairement le sort qui attendait celle de Grand-Pré, que leur désespoir fut inexprimable.[2]

Ces deux temples surmontés de leurs gracieux clochers, et dont les boiseries intérieures, sculptées avec goût, étaient toutes en bois de chêne, leur avaient coûté tant de sacrifices! Qu'étaient devenus les vases sacrés, les ornements d'église, dont plusieurs, fort riches, leur avaient été envoyés en présent par le roi Louis XIV?[3] C'était à la garde de leurs églises qu'ils avaient confié leurs morts abandonnés dans les cimetières. Ils avaient encore dans l'oreille les sons joyeux des cloches qui les appelaient aux offices des dimanches et qui leur annonçaient l'angelus de l'aurore et du soir. Hélas! ils savaient qu'ils

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[1] Il n'y eut guère d'épargné que les blés mis en farine pour la nourriture des troupes et des déportés.

[2] Bâtisses brûlées par Winslow dans le district des Mines:

Nov.		Maisons.	Granges.	Autres bâtisses.
2	A la rivière Gaspareaux	49	39	19
5	A la rivière aux Canards, des Habitants, Perreault.	76	81	33
6	A la rivière aux Canards et des Habitants	85	100	75
7	A la rivière aux Canards et des Habitants	45	56	28
		255	276	155
				276
				255
	Moulins en différents endroits			11
	Eglise			1
	Total			698

Le capitaine Osgood, resté quelques jours après le départ de Winslow, brûla l'église de Grand-Pré, qui avait servi de caserne, et ce qui restait de maisons.

[3] Le roi avait donné en 1705 un calice, un ciboire, un ostensoir en argent massif, et un ornement complet.

allaient être jetés dans des contrées où ils ne verraient plus ces beaux offices, ni la robe noire de leurs prêtres !

Quand les habitants de Port-Royal réfugiés dans les bois avaient vu, comme eux, leurs maisons incendiées, ils n'avaient pas osé sortir de leur retraite ; mais quand ils avaient vu mettre le feu à leur église, ils s'étaient élancés furieux sur les incendiaires, en avaient tué ou blessé vingt-neuf et mis les autres en fuite ; puis ils s'étaient rejetés dans les bois.

Décembre était avancé quand Winslow eut fini son œuvre de destruction. Il ne s'était pas hâté de prendre la mer, afin d'emmener ceux des fugitifs que la faim et la misère forçaient de sortir des bois. Les derniers embarqués mirent à la voile, dans l'après-midi du 20 décembre, au nombre de deux cent trente-deux sur deux goëlettes : l'une à destination de Boston, l'autre de Virginie.

Il semble que Longfellow, qui a si bien chanté les malheurs des Acadiens, et qui, paraît-il, n'a jamais vu Grand-Pré, ait été assis en face du cap Blomedon, lorsqu'il écrivit ce beau passage par où s'ouvre son poème d'Evangeline :

This is the forest primeval. The murmuring pines and the hemlocks,
Bearded with moss, and in garments green, indistinct in the twilight,
Stand like Druids of old, with voices sad and prophetic,
Stand like harpers hoar, with beards that rest on their bosoms.
Loud from its rocky caverns, the deep-voiced neighbouring ocean
Speaks, and in accents disconsolate answers the wail of the forest.

This is the forest primeval ; but where are the hearts that beneath it
Leaped like the roe, when he hears in the woodland the voice of the huntsman ?
Where is the thatch-roofed village, the home of Acadian farmers, —
Men whose lives glided on like rivers that water the woodlands,
Darkened by shadows of earth, but reflecting an image of heaven ?
Waste are those pleasant farms, and the farmers for ever departed !
Scattered like dust and leaves, when the mighty blasts of October
Seize them, and whirl them aloft, and sprinkle them far over the ocean !
Nought but tradition remains of the beautiful village of Grand-Pré.

" C'est la forêt primitive. Les pins murmurants et les mélèzes vêtus de leur barbe de mousse et de leur robe de feuillage, se dressent, vagues et confus dans le crépuscule, comme les druides d'autrefois, et font entendre des voix tristes et prophétiques. L'océan voisin jette sa grande voix dans les cavernes sonores des rochers, et ses accents inconsolables répondent aux soupirs de la forêt.

" C'est la forêt primitive ; mais où sont les cœurs qui battaient comme celui du chevreuil, quand il entend dans la bruyère la voix du chasseur ? Où sont les toits de chaume du village, la demeure de l'habitant acadien, dont la vie voilée par les ombres de la terre, mais reflétant l'image des cieux, s'écoulait comme les ruisseaux qui arrosent les terres vierges ? Les chaumières dévastées ont disparu, et leurs habitants sont partis pour toujours, dispersés comme la poussière et les feuilles, quand les violentes rafales d'octobre les saisissent et les font tourbillonner dans l'air et pleuvoir au loin sur l'océan ! Du joli village de Grand-Pré, il ne reste plus rien que la tradition."

XV

L'abbé LeGuerne a raconté quelques-unes des scènes navrantes dont il avait été témoin : [1]

" La plupart des malheureuses femmes (des environs de Beauséjour) séduites par de fausses nouvelles... emportées par l'attachement excessif pour des maris qu'elles avaient eu permission de voir trop souvent, fermant l'oreille à la voix de la religion, de leur missionnaire et à toute considération raisonnable, se jetèrent aveuglément et comme par désespoir dans les vaisseaux anglais. On a vu dans cette occasion le plus triste des spectacles ; plusieurs de ces femmes n'ont pas voulu embarquer avec leurs grandes filles et leurs grands garçons par le seul motif de la religion. [2]

L'expédition dirigée contre Cobequid trouva le village abandonné, et ne put qu'incendier les maisons. Les Cobequites, (c'est ainsi qu'on les appelait), traversèrent dans l'île Saint-Jean, (île du Prince Edouard), où ils espéraient se mettre à l'abri de nouvelles attaques ; mais ils n'étaient qu'au commencement de leurs malheurs.

Ils furent rejoints par cinq cents autres fugitifs des environs de Beauséjour et de Tintamarre qu'y fit passer l'abbé LeGuerne.

La destination des déportés avait été prévue d'avance par le gouverneur Lawrence qui, d'Halifax, avait dirigé toutes les opérations. Ils devaient être débarqués dans les principaux ports de mer du littoral américain, depuis la Nouvelle-Angleterre jusqu'à la Géorgie, c'est-à-dire sur une étendue de plusieurs centaines de milles. Cet ordre, dont peut-être Lawrence n'aperçut pas toutes les conséquences, fut le plus barbare et le plus fatal aux Acadiens, car il mettait un grand nombre de familles séparées dans l'impossibilité de se retrouver.

Aucune raison ne peut justifier un pareil acte ; il eût été au contraire de bonne politique d'établir les Acadiens ensemble dans quelqu'une des provinces éloignées, où leur présence n'aurait offert aucun danger, où ils se seraient multipliés avec la rapidité qu'on leur connaissait, et où ils auraient fini par devenir les citoyens fidèles de la grande république.

Pendant que les transports cinglaient sur la baie de Fundy, un Acadien de Port-Royal, du nom de Beaulieu, ancien navigateur au long cours, ayant demandé au capitaine du navire où il était détenu avec deux cent vingt-quatre autres exilés, en quel lieu du monde il allait les conduire :

— Dans la première île déserte que je rencontrerai, répondit-il insolemment. C'est tout ce que méritent des papistes français comme vous autres.

Hors de lui-même, Beaulieu, qui était d'une force peu ordinaire, lui asséna un coup de poing qui l'étendit sur le pont. Ce fut le signal pour les autres captifs, qui probablement s'étaient concertés d'avance. Quoique sans armes, ils se précipitèrent sur leurs gardes, en tuèrent quelques-uns et mirent les autres hors de combat.

Beaulieu prit ensuite le commandement du transport, et alla l'échouer dans la rivière Saint-Jean, près de la mission que dirigeait alors les PP. Germain et De la Brosse.

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[1] L'abbé LeGuerne, qui a laissé une relation des événements de 1755, était natif de Bretagne. Homme de science, poète même à ses heures, il devint, après son retour des missions, professeur de philosophie au séminaire de Québec, à qui il légua sa bibliothèque et ses manuscrits. Il mourut en 1789, curé de Saint-François de l'Ile d'Orléans.

[2] *Lettre de M. l'abbé LeGuerne*, 10 mars, 1756.

Durant les cinq années de guerre qui suivirent l'automne de 1755, toute la Nouvelle-Ecosse fut sillonnée de partis d'éclaireurs qui firent une chasse implacable aux fugitifs acadiens. Ceux-ci s'étaient divisés en deux courants : l'un qui remontait par étapes vers les frontières du Canada ; l'autre qui inclinait vers l'extrémité de la presqu'île, espérant trouver quelque asile inaccessible et des moyens de vivre au bord de la mer. L'abbé Desenclaves, qui avait accompagné une partie de ces derniers dans leur fuite de Port-Royal, se trouvait encore au milieu d'eux en 1756, dans les environs du Cap-Sable. On voit quel était leur sort par l'extrait suivant d'une lettre qu'il écrivait à Québec en date du 22 juin : " Nous sommes en prières, disait-il, pour obtenir sur nous les miséricordes du Seigneur, mais il est à craindre que nos paroles ne manquent de la force d'une foi vive. Tout le Cap de Sable avait été à couvert de toute insulte jusqu'au 23 avril, qu'un village fut investi et enlevé ; tout fut brûlé, et les animaux tués ou pris, et une maison à quatre lieues de là eut le même sort, le même jour. Le dimanche après la Passion, on pillait une maison et on prit les bestiaux appartenant à M. Joseph Dentremont qui avait été pris à la pêche avec un fils à lui, un à sa femme et un garçon du Port-Royal. Il y avait à une petite lieue de la maison, mon presbytère et une modeste chapelle ; ils n'y ont pas encore été, ils n'ont pas même brûlé un petit oratoire que j'avais où ils ont été, le lundi de la Pentecôte. Ils forcèrent sans doute M. Joseph Dentremont de les conduire chez ses enfants dont ils en tuèrent un, lui enlevèrent la chevelure, pillèrent leur cabane, qu'ils brûlèrent ; ils emmenèrent quelques animaux. Les autres enfants ont pris la fuite, tout le reste s'est retiré dans les bois faisant garde en cas de surprise. Je compte qu'ils auront de la peine à me trouver avec une vingtaine d'âmes qui sont avec moi ; nous n'avons rien laissé dans nos maisons, pas plus que dans l'église ; nous attendons ici la miséricorde du Seigneur. Si les choses ne s'accomodent pas, nous ferons notre possible pour gagner la rivière Saint-Jean au printemps ; si elles s'accomodent et que Mgr le veuille, j'irai finir mes jours dans quelque coin de communauté en Canada. Sinon, il faudra que je passe en France d'où j'ai reçu des lettres d'instances tout fraîchement. Plaise à la miséricorde de Dieu de me faire connaître sa sainte volonté. Souvenez-vous de nous dans vos saints sacrifices." [1]

Cette lettre laissait assez prévoir ce qui devait arriver : l'abbé Desenclaves et son petit troupeau furent cernés, embarqués sur un navire et envoyés à Boston.

Malgré ces dragonnades, un certain nombre de familles, entre autre celles du bassin des Mines et de Port-Royal, qui passèrent l'hiver de 1756 dans le voisinage de la baie de Fundy, parvinrent à se tenir cachées jusqu'à la conclusion de la paix, grâce surtout à l'amitié des sauvages. Ralliées ensuite par les missionnaires, leurs seuls et inséparables amis, et rejointes par d'autres familles acadiennes, revenues de l'exil, elles ont été l'origine des florissantes paroisses qu'on voit aujourd'hui autour de la baie Sainte-Marie.

XVI

Du site aujourd'hui désert qu'occupait Grand-Pré, on aperçoit un bon nombre d'habitations disséminées sur les hauteurs qui s'arrondissent autour du bassin des Mines ; mais, hélas ! pas une de ces maisons n'est habitée par des Acadiens. Elles ont été bâties sur les cendres de leurs foyers, par des hommes étrangers à leur race, qui vivent en paix et richement sur ces domaines que d'autres mains avaient ouverts à la culture. Cette

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[1] *Archives de l'archevêché de Québec.*

pensée me donnait un serrement de cœur, chaque fois qu'en traversant la Grand'Prée, je jetais un coup d'œil sur le paysage environnant.

Avant de m'éloigner, je voulus suivre le chemin qu'avaient parcouru les exilés jusqu'au lieu de l'embarquement. Là, assis sur le talus de la grande digue au pied de laquelle venait battre l'océan, je restai longtemps à écouter le bruit mélancolique de ces mêmes flots qui avaient mêlé leurs gémissements à ceux des infortunés bannis. J'ouvris *Evangeline* et j'en lus les principaux passages. On conçoit ce que peut avoir de charmes une telle lecture faite sur le théâtre même des événements. J'invite ceux qui ont pris quelque intérêt à ce qui précède à relire le poème d'*Evangeline ;* ils se convaincront, malgré ce qu'ils ont pu voir de contraire dans des publications récentes, que la touchante élégie de Longfellow est en tout point l'écho fidèle et poétique de la tradition.

9 octobre. — Au lever du soleil, promenade à pied sur les montagnes qui dominent Kentville. On y jouit d'une vue à vol d'oiseau de la vallée par où coule la rivière Gaspareaux, et du bassin des Mines, dont on est éloigné d'environ sept milles ; c'est un des plus gracieux panoramas de l'Amérique du Nord.

Départ de Kentville par le train du matin. Le long de la route, comme en plusieurs endroits de la Nouvelle-Ecosse, je suis choqué des cris que poussent des attroupements d'enfants à l'arrivée du train aux gares ; on dirait des hurlements de loups furieux. Quelle différence avec l'excellente tenue de la foule qu'on rencontre dans les gares de chemin de fer de la province de Québec. Si de pareilles inconvenances se commettaient dans nos campagnes, les réprimandes sévères des curés y auraient bien vite mis un terme. On qualifie nos habitants de *priest ridden.* Je ne sais jusqu'à quel point les Néo-Ecossais écoutent leurs ministres ; mais je puis assurer qu'ils n'y perdraient pas sous le rapport de la politesse, s'ils apprenaient à vivre sous la houlette de nos pasteurs.

Le chemin de fer côtoie la rivière Annapolis (autrefois rivière Dauphin) depuis sa source jusqu'à son embouchure. Voici la Prée-Ronde, où florissait jadis une paroisse acadienne. Il n'en reste aucune trace, pas plus que de celle de Port-Royal, petite ville toute anglaise qui ne répond plus qu'au nom d'Annapolis. Elle n'a d'autre intérêt que les ruines de son fort, aujourd'hui abandonné comme celui de Beauséjour. C'est le même système de fortification en terre, sur une plus grande échelle. La poudrière placée à l'abri d'une des courtines est très bien conservée et remarquable par la force de ses voûtes en plein cintre, dont les larges et épaisses briques ont la blancheur et la dureté du marbre.

J'ai pour cicerone M. le juge Cowling, antiquaire du lieu, à qui m'a présenté en arrivant un excellent avocat d'Annapolis, M. Chesley, dont j'ai fait l'heureuse rencontre dans le train.

Le juge, dont la conversation est très intéressante, me dit avec regret que le même esprit de mercantilisme ignare qui a failli faire perdre à Québec son cachet d'antiquité en lui enlevant ses fortifications, règne à Annapolis. Des spéculateurs ont fait des tentatives auprès du gouvernement fédéral pour faire mettre en vente les terrains qu'occupe le fort.

— Ne serait-ce pas un crime de lèse-antiquité ? ajoute le juge Cowling. Si l'attention du ministre était attirée sur ce sujet, nul doute qu'il ne prendrait des mesures pour faire veiller à la conservation de ces monuments du passé auxquels se rattachent tant de souvenirs et qui sont si rares sur notre continent.

Dans l'après-midi, excursion en voiture vers le haut de la rivière, au petit village

d'Equille situé à deux milles de Port-Royal. Sur la falaise très escarpée au pied de laquelle coule la rivière, se voit encore des restes de fortifications d'une assez grande étendue. Au milieu d'un verger voisin une excavation indique l'endroit où existait, paraît-il, une chapelle bâtie par les Français ; on y a découvert quelques petits ustensiles en or, qui ont dû servir à la mission. J'ai vu dans le salon du propriétaire de ce verger, M. Hoyt, deux de ces objets et plusieurs pointes de flèches et de lances en pierre taillées par les sauvages, et qui ont été trouvées dans les alentours.

10 octobre. — Départ d'Annapolis pour Saint-Jean, Nouveau-Brunswick. On comprend pourquoi les Français ont donné au bassin que nous traversons le nom de Port-Royal, quand on le parcourt par une journée resplendissante comme celle dont nous jouissons. Cette vaste nappe d'eau qui ressemble à un lac, et qui ne communique avec la mer que par un étroit passage, est encaissée entre des hauteurs cultivées couronnées d'une guirlande de forêts toujours vertes. Toutes les flottes du monde pourraient y ancrer à la fois et y manœuvrer à l'aise.

Du *gut* de Digby à Saint-Jean, traversée très agréable par un beau clair de lune et un calme parfait.

Deux jours après, je rentrais à Québec par l'Intercolonial, emportant avec moi des impressions et des souvenirs dont ces notes de voyage ne sont qu'un vague reflet.

IV — *Oscar Dunn,*

Par M. A. D. DECELLES.

(Lu le 25 mai 1886.)

Parmi les tombes que nous avons vues se creuser en si grand nombre, des deux côtés de notre route, depuis dix-huit mois, et que peut-être nous avons, hélas ! presque toutes oubliées, tellement ces deuils multipliés finissent par ne laisser que des impressions fugitives, il s'en trouve une portant un nom que nous ne pouvons encore aujourd'hui prononcer sans éprouver un serrement de cœur. Ce nom éveille sans doute, chez vous comme chez moi, des regrets aussi vifs, si j'en juge par ce que je ressens, que le jour où la fatale nouvelle nous arrivait que sa main venait soudain de se glacer dans celles de l'ami qui le voyait passer, sans transition, de la vie active aux torpeurs de la mort. Vous ne l'avez pas oublié, en dépit des événements de tous genres qui sont venus nous impressionner si fortement pendant ces derniers mois ; vous ne l'avez pas oublié parce que DUNN appartenait à cette catégorie peu nombreuse d'hommes dont la perte est un véritable deuil, et qui laissent dans la mémoire de ceux qui les ont aimés de longs et durables souvenirs. C'était une physionomie d'élite qui ne pouvait rester dans l'ombre ; c'était une nature originale qui se détachait en un vif relief sur l'uniformité de la foule ; par-dessus tout, c'était un ami qui ne tenait pas à ceux qui l'affectionnaient par ces attaches banales d'un jour, nouées trop facilement, et rompues sans peine et sans secousse. Aussi quels regrets dans les milieux où il avait été répandu, lorsque l'on apprit sa fin foudroyante ! Ai-je besoin de peindre la poignante émotion que vous avez ressentie comme moi ? Ai-je besoin de rappeler ces exclamations de douleur qui éclataient à Québec et qui trouvaient d'unanimes échos parmi ses amis de Montréal et d'Ottawa ? Nous qui n'avions pas été témoins du coup de foudre qui l'a enlevé, nous ne pouvions plus nous revoir sans donner cours à nos tristes pensées. Je n'ai jamais vu l'amitié survivre à la séparation suprême avec des souvenirs plus persistants mêlés à des regrets plus affectueux.

Si, le 15 avril 1885, nous étions frappés dans nos affections les plus vives, ce jour-là, les lettres canadiennes et la Société Royale se sentaient, elles aussi, atteintes dans leurs plus chères espérances. Elles voyaient disparaître à 40 ans — âge où dans les autres pays, l'on commence généralement à se faire jour au sein de la foule — un homme à qui nous devons tant de travaux intellectuels, un publiciste qui a éparpillé dans une demi-douzaine de journaux, à Paris, à Québec, à Montréal, tant d'écrits fortement pensés, d'une forme si personnelle, d'une spontanéité si prime-sautière.

Dunn était une de ces rares individualités qui, par la force de leur caractère, la nature de leur esprit, arrivent forcément aux premiers rangs. Marquées en quelque sorte du sceau du génie, emportées par une puissance extraordinaire, elles s'imposent à leur entourage, font accepter leur empire dans le domaine de l'intelligence. Il s'était révélé ce

qu'il serait, de bonne heure. "Dès ses premières années au collège de Saint-Hyacinthe, me disait un de ses anciens condisciples, Oscar Dunn était un élève hors de pair ; nous sentions une supériorité chez lui ; déjà s'ébauchait dans sa personne et ses manières la figure si caractéristique que nous avons connue. Aussi ses précepteurs le surveillaient-ils d'une façon toute spéciale comme un élève appelé à de belles destinées." A cette considération que lui valait sa nature d'élite, s'ajoutait un sentiment d'intérêt tout particulier qu'avaient fait naître les contestations judiciaires dont il avait été l'objet dans son enfance. On savait que, né d'un père protestant et d'une mère catholique, il était resté orphelin fort jeune, et que les deux familles, représentant son père d'une part et sa mère de l'autre, s'étaient disputées devant les tribunaux pour savoir s'il serait écossais et protestant, ou canadien-français et catholique. Cette contestation, qui avait fait dépendre de la parole d'un seul homme toute sa destinée, avait beaucoup impressionné Dunn, et elle ne fut pas sans influence sur ses idées. Est-ce à cet épisode si singulier de sa vie qu'il devait cette aversion si prononcée pour tout ce qui peut provoquer, dans notre état social, des animosités religieuses ou nationales ? N'est-ce pas ce sentiment qui plaçait sur ses lèvres, quelques minutes avant sa mort, le vœu que les tristes événements du Nord-Ouest se dénoueraient sans catastrophe de nature à amener un choc entre les différentes nationalités de notre pays ?

Pour un bon nombre des étudiants que nos collèges versent chaque année dans notre société, la vie publique se présente sous les dehors les plus fascinateurs ; c'est la terre promise, l'Eden que leurs lectures, leurs études littéraires et historiques leur ont fait rêver ; c'est l'avenue large et facile où l'on s'élance pour devenir Richelieu, Pitt, Cavour, Gladstone ou d'Israéli. Hélas ! ces pauvres inexpérimentés, éblouis de loin par de rares succès que dissimulent à peine bien des revers de médailles, se doutent peu que cette avenue, qui, dans leur imagination, mène à tout, ne conduit le plus souvent, dans la réalité, qu'aux dégoûts, aux déceptions et parfois à la ruine ; ils ne se doutent pas de combien de misères, de sacrifices sont tressées les plus belles couronnes que nous offre la décevante politique ; ils ne se doutent pas quelle chaîne de désillusions portent en même temps ses rares élus ! Oscar Dunn, avec sa nature généreuse, ses nobles instincts, ses grands rêves d'avenir, subit à un haut degré la fascination de la politique. Mais son ambition avait un but élevé, et il était trop fier, avait une trop haute idée de ce qu'il voulait entreprendre pour ne pas se préparer de la manière la plus sévère à la carrière qui l'attirait, et où il devait éprouver tant de déceptions !

Il lui semblait que la meilleure préparation à la vie publique était le journalisme, qui, dans les conditions où il pouvait y entrer, le mettrait d'emblée en rapports avec les hommes marquants du pays, lui permettrait d'étudier toutes les questions qui devraient être familières à quiconque aspire aux premiers rôles du théâtre parlementaire. A peine sorti du collège, il passa sans transition du banc de l'écolier au fauteuil de rédacteur du *Courrier de Saint-Hyacinthe.* Il fit son apprentissage à rude école. Dès ses débuts, tout d'abord très remarqués, il eut pour adversaire un homme qui a été regardé comme un de nos plus forts polémistes ; la lutte s'engagea à la fois sur la politique et sur des questions de religion. Dunn, armé comme on peut l'être au sortir d'une classe de philosophie, eut toutes les audaces de la jeunesse qui l'empêchaient de se rendre compte de la force de son adversaire et de douter de la sienne ; il ne poussa pas cependant l'assurance jusqu'à négliger de fourbir ses armes par des études sérieuses et soutenues. Cette polémique politico-

religieuse, qu'il mena plusieurs années durant contre M. Dessaulles, attira les yeux sur le jeune écrivain. Il eut bientôt son petit cercle d'admirateurs qui ne lui ménagèrent pas les applaudissements. Cette gloriole des premiers succès dont se gorgent et se contentent trop d'aspirants à la renommée, et qui en perd un grand nombre, ne l'éblouit point. Il n'y vit qu'un coup d'aiguillon, un encouragement à faire mieux, ayant trop de valeur, trop le sentiment de la perfection pour ne pas sentir qu'il était loin d'avoir ville gagnée. Aussi saisit-il avec empressement l'occasion qui se présenta d'aller étudier à Paris. Il voulait en quelque sorte refondre, sous la surveillance de maîtres expérimentés, l'instrument si riche qu'il possédait, le couler dans un nouveau moule, afin d'être certain qu'il rendrait un son bien français. Il ne fut ni étonné, ni froissé lorsque ses aînés au *Journal de Paris* lui firent comprendre, en lui rendant ses essais chargés de corrections, qu'il lui restait — ce dont il se doutait — beaucoup à apprendre dans l'art si difficile d'écrire la langue de Racine et de Victor Hugo.

Vous voyez, Messieurs, quelle idée Dunn s'était faite du journalisme et des études qu'il exige chez ceux qui le regardent comme une carrière ingrate, si vous voulez, mais après tout très honorable. Il serait à souhaiter que ses opinions fussent partagées par un plus grand nombre de ses successeurs qui croient n'avoir plus rien à apprendre dès qu'ils ont agencé quelques phrases boiteuses dans un journal, et qui se posent en écrivains parce qu'ils sont lus, la passion politique faisant tout accepter, jusqu'aux choses les plus incroyables. Ce n'est pas ainsi que Dunn entendait le journalisme, qui, à son sens, était une profession, tandis que pour d'autres il n'est qu'un de ces métiers faciles qui se peuvent exercer sans apprentissage.

A son retour au Canada, Dunn fit partie de la rédaction de la *Minerve*, et c'est dans les colonnes de ce journal qu'il mena avec tant de verve et de vigueur, cette brillante série de campagnes dont se souviennent encore les dilettanti de la politique. Il arriva bientôt à exercer une véritable influence non seulement à Montréal, mais dans une grande partie de notre province. Pour ne citer qu'un effet de l'autorité de sa parole, qu'il me soit permis de rappeler que personne ne contribua plus que lui à former l'opinion publique, lorsque ce que l'on appelle l'*affaire Guibord* vint mettre en émoi le district de Montréal. La population ne paraissait pas d'abord saisir toute la portée de cette cause célèbre ; elle ne s'en rendait pas un compte bien exact, et, tout en s'inclinant devant l'autorité diocésaine, elle réclamait des explications. Une série d'articles d'une force de logique peu ordinaire, écrits avec cette chaleur et cette clarté qui étaient la caractéristique de sa manière, portèrent la conviction dans les esprits ; et l'accord de la raison avec la foi aux décisions de l'évêque couronnèrent cette démonstration, qui n'aurait pas déparé l'œuvre d'un casuiste.

Ce sera peut-être une révélation pour plusieurs d'entre nous, d'entendre dire que Dunn s'était nourri pendant plusieurs années de saint Thomas d'Aquin, et qu'il faisait alterner l'étude de l'Ange de l'Ecole avec celle de l'histoire, du droit et de l'économie politique. Il faisait peu de cas de la littérature légère, lisait peu ou point de romans, et avait en horreur tout ce qui sentait l'imitation de la chronique parisienne. Son genre d'étude déteignait sur son style. Rarement, il laissait carrière à son imagination. Il allait droit au but, visait à la concision, avec une affection particulière pour le trait, le mot qui frappe juste. Il excellait à trouver la note exacte, pleine d'actualité, à réduire ses idées en formules qui se gravent dans l'esprit, qui peignent une situation ; il était arrivé à donner à ses pensées une intensité souvent remarquable. Personne n'enlevait comme lui

l'article d'actualité sur l'événement encore tout chaud ; personne ne s'entendait comme lui à arriver bon premier, pour créer au plus tôt cette impression qui reste souvent sur un fait tombé dans le domaine de la notoriété publique. Il avait en horreur les longs articles qui se traînent d'une colonne à l'autre. Parler haut et peu de temps, telle semblait être pour lui la devise du journaliste qui veut diriger l'opinion publique.

Je ne voudrais pas m'attarder à parler de son bon labeur à la *Minerve*, mais je ne puis m'empêcher de signaler une longue discussion à laquelle il prit une part active : c'est celle qui s'engagea dans la presse au sujet de l'université Laval. Je n'ai pas besoin de dire que, mettant de côté tout esprit de clocher, toute rivalité de ville, qui paraît mesquine lorsqu'il s'agit de l'œuvre nationale et religieuse la plus en vue en Amérique, il embrassa la cause de cette grande institution. Il était convaincu, — permettez-moi de dire nous étions convaincus, puisque je combattais à ses côtés, — que la cause de Laval était intimement liée aux plus chers intérêts de notre famille française, et que, si cette institution, dont chaque pierre coûtait un sacrifice, ou représentait un élan de dévouement à la patrie, à l'éducation, était perdue, la cause nationale elle-même en recevrait une terrible atteinte. Qui voudrait à l'avenir se sacrifier pour le pays, si des sacrifices qui se chiffraient par des milliers de dollars, si des actes de dévouement qui s'enchaînaient les uns aux autres depuis vingt-cinq ans, étaient tenus en si mince estime par ceux qui étaient appelés à en profiter le plus ?

C'est vers 1872 que je devins son collaborateur à la *Minerve*, et, s'il m'était permis de mêler quelques souvenirs personnels à ces pages, je dirais que les années que j'ai passé avec lui compteront parmi les plus heureuses de ma vie. Il était impossible de se donner un meilleur ami et un plus agréable camarade. Quel heureux temps si tôt envolé ! Combien il a fui trop vite en emportant dans son cours tout ce qui compose le trésor des illusions et des bonheurs rêvés, mais pas même entrevus ! Sans souci de la fortune, un peu blasés sur les invites du monde, nous allions gaîment notre chemin, plus heureux que les millionnaires les plus enviés de la ville. Tout entier au journal, nous y traitions les questions du jour avec entrain, avec plaisir même ; nous nous amusions parfois à y développer des théories sur les finances, que nous ne pouvions pas, dans la pratique, soumettre à l'épreuve de l'application, à risquer des opinions politiques qui effarouchaient les amis du journal, et que l'on mettait sur le compte des écarts de la jeunesse. De délicieuses promenades à travers la ville venaient interrompre agréablement nos travaux, que nous reprenions à notre retour quand nos bureaux n'étaient pas encombrés de personnes venues de tous les points de la province. L'heure du lunch était la plus joyeuse de la journée. Autour de la table du restaurant que nous honorions de notre confiance, sinon de nos folles dépenses, se trouvaient toujours avec nous une foule d'amis prêts à commenter, à critiquer nos articles du matin. C'était l'heure de la conversation lancée à grand orchestre. Elle prenait une tournure absolument orageuse, quand Dunn, pour amuser les convives, amenait la discussion sur un terrain où ses idées se heurtaient à celles d'Achintre, un des convives habituels, qui apportait là toute l'exubérance du Midi, toute la fougue de la Provence. Les badauds, attirés par le bruit, croyaient qu'on allait s'égorger. Vous voyez leur naïve surprise lorsque, quelques minutes plus tard, après le café, ils apercevaient les bruyants convives sortir bras dessus bras dessous pour reprendre d'une façon aussi prosaïque que pacifique le chemin du bureau. Pardon, Messieurs, de m'être laissé aller à ces souvenirs. J'ai voulu marquer comment on faisait du journalisme à Montréal, en l'an de grâce 1872.

Comme je le disais tantôt, le journalisme ne pouvait être pour lui qu'une étape. Ce n'est pas ici une carrière où l'on puisse s'établir d'une façon permanente. Excellente école, le journalisme finit par amener la lassitude, et souvent l'homme de valeur qui s'y trouve attaché, s'aperçoit qu'après avoir poussé la fortune de tant d'autres, il n'a pas avancé la sienne. Dunn tenta d'entrer au parlement, à deux reprises, en 1872 et en 1875, aux élections générales qui eurent lieu à ces époques. Il ne put conquérir assez de suffrages pour obtenir un mandat. On dit que le plaideur malheureux a vingt-quatre heures pour maudire son juge ; le candidat déconfit jouit d'un privilège analogue : celui de prouver à qui veut l'entendre que s'il a été battu il n'y est pour rien, et qu'au contraire, si ses amis avaient suivi ses instructions, ou que s'il n'avait pas été trahi à la dernière heure. il aurait certainement été élu à une majorité fabuleuse. Notre ami ne versa jamais dans cette faiblesse. Il aurait pourtant eu le droit de déplorer sa défaite et d'en éprouver de profonds dégoûts ; mais, s'il en éprouva, jamais candidat battu ne dissimula mieux son amour propre froissé, et ne supporta mieux un revers.

Dunn, entrant dans la vie publique, aurait voulu y faire aussi bonne figure que dans le journalisme. Le parlement était à ses yeux une illustre assemblée, dont nul ne devait faire partie s'il ne se sentait de force à ajouter à son prestige. Mais avait-il choisi le meilleur moyen de réussir ? Le peuple ne demande pas autant de sacrifices à ses élus ; il les veut plus près de lui, placés moins haut, plus accessibles. Comme tous les hommes d'étude, Dunn ne connaissait pas le peuple, et négligeait trop les habiletés nécessaires au candidat qui veut faire la chasse aux électeurs. Ceux-ci, très indifférents à ces études qui avaient tant de prix aux yeux de Dunn, sont plus sensibles aux petites ruses, aux bons offices qui vont droit au cœur. C'est pourquoi nous voyons toujours au parlement beaucoup plus de candidats élus que de candidats véritablement dignes de l'être.

Après son insuccès de 1875, il entra au ministère de l'Instruction publique à Québec, tout en caressant l'espoir, comme il m'en a souvent fait la confidence, que les événements lui permettraient un jour de réaliser ses espérances. Dans cette nouvelle sphère, il eut bientôt donné des aliments à son activité et à son besoin d'action. Il ne se laissa pas envahir par cette somnolence intellectuelle qui vient trop souvent surprendre le fonctionnaire public condamné, par état, à une besogne routinière, ne laissant aucun élan à l'initiative individuelle, et fatale à bien des esprits d'élite. On le vit s'occuper de projets qui avaient pour but de favoriser les intérêts matériels de la littérature canadienne, tout en contribuant à répandre davantage l'instruction populaire. Ils ont été jugés diversement, mais, quel qu'en fût le mérite, ils n'en témoignent pas moins d'un désir sincère de travailler à la chose publique.

Il continuait ses études, et pour y faire diversion, en même temps que pour répondre à ceux qui nous accusaient, nous Canadiens-français, de parler un patois incompréhensible hors de la province de Québec, il publia son *Glossaire franco-canadien*, remarquable travail, qui, malgré quelques erreurs, n'en reste pas moins un des titres les plus sérieux à la considération qui s'attache à son nom. Bien accueilli au Canada, apprécié de la façon la plus flatteuse en France, le *Glossaire* aurait eu, peu de temps après sa publication, les honneurs d'une seconde édition, si la mort lui avait laissé le temps de la préparer.

A Québec, cette ville si française par l'esprit et le cœur, Dunn conquit l'amitié de ceux qui furent à même de le connaître. Il se fit remarquer dans un cercle qui comptait pour membres les esprits les plus cultivés de cette ville si attique. Tous l'aimaient

comme nous l'avions aimé à Montréal. C'était un ami comme il s'en rencontre rarement, le cœur et la bourse toujours ouverts, n'ayant que le regret de n'avoir pas la bourse aussi grande que le cœur. Que d'amis dans la détresse l'ont trouvé secourable ? C'était vers les amis dans l'adversité — chose assez rare — qu'il se sentait le plus fortement attiré.

Brillant causeur, aimant la société des intimes, il apportait dans les réunions la vie et la gaieté. Il avait une façon à lui de raisonner ; il entrait brusquement en matière, d'un ton qui paraissait cassant, et qui pour nous n'était que l'éclat de sa franchise. D'une grande fermeté de caractère, plein d'égards pour ceux qui ne partageaient pas ses opinions, il est resté du commencement à la fin de sa carrière solidement ancré dans ses croyances. Catholique avant tout, il se disait heureux d'avoir conservé la foi de son jeune âge dans son intégrité. En passant à Rome, lors de son voyage en Europe, il avait été présenté au Saint Père comme journaliste catholique, et il aimait à rappeler les incidents, de cette audience. Lorsque, après sa sortie de la presse, il réunit en volume ses principaux articles, il donna pour épigraphe à ce recueil ces paroles que Pie IX lui avaient adressées : " Vous êtes bon catholique ; soyez droit d'intention, et Dieu vous sauvera de toute erreur." Lorsque, pendant les derniers temps de sa vie, quelques ennemis personnels firent planer des doutes sur son orthodoxie, il en ressentit de vives angoisses. Dédaignant de répondre à ses détracteurs, auxquels il n'aurait eu qu'à montrer ses états de service pour les écraser, il écrivit à l'autorité religieuse, de cette plume qu'il avait souvent et si utilement employée à la défense de l'Eglise, une énergique protestation pour revendiquer l'honneur de sa foi indignement mise en suspicion.

Hier, en jetant les yeux sur les pages éloquentes qu'il écrivait à la mémoire de Lucien Turcotte, enlevé comme lui au milieu de la vie, en pleine maturité de talent, je me suis arrêté sur ce passage que je vais vous lire : " Hélas ! que nous reste-il de ce grand cœur, de cette belle intelligence ? Un simple souvenir. C'est beaucoup pour l'exemple qu'il nous retrace ; qu'est-ce pour notre amitié ? qu'est-ce pour la patrie, qui fondait tant d'espérances sur son enfant ? On dirait qu'une fatalité pèse sur les jeunes gens doués de génie. Les uns sont annihilés par les circonstances ou par les persécutions, les autres s'anéantissent eux-mêmes par la paresse ou les habitudes, et la mort enlève les plus irréprochables. Remontez seulement à vingt années en arrière ; comptez tous les jeunes gens marquants et même célèbres qui sont disparus de la scène pour des causes diverses, et dites si notre nationalité n'est pas bien malheureuse de perdre ainsi tant de nobles défenseurs, sans avoir obtenu d'eux les services qu'ils pouvaient rendre ?

Le ciel de ces élus devient-il envieux,
Ou faut-il croire, hélas ! ce que disaient nos pères,
Que lorsqu'on meurt si jeune on est aimé des dieux ?

" Qui méritait plus que Lucien Turcotte une longue vie ? On serait tenté de croire à l'injustice du sort qui ne lui a pas permis de travailler longtemps pour son pays, si l'on ne savait que Dieu veille sur les peuples et les individus avec une infinie miséricorde."

Ne dirait-on pas, Messieurs, que ces lignes ont été écrites pour Dunn lui-même, et ne vous semble-t-il pas que je ne puis mieux terminer, qu'en les lui appliquant, ce travail consacré à sa chère mémoire ?

V — *Les pages sombres de l'Histoire,*

Par J. M. LEMOINE.

(Lu le 26 mai 1886.)

La dispersion projetée des habitants de la Nouvelle-York, 1689. — *Le massacre de Glencoe*, 1692. — *La dispersion des Acadiens*, 1755.

MESSIEURS, — J'aime à me figurer l'Histoire comme un drame prolongé, varié, plein de mystère, où le sombre l'emporte sur le gai, les ombres sur les rayons. Elle a, n'en doutons pas, plusieurs phases.

Il en est une, selon moi, fort intéressante — utile, dirai-je — à étudier : celle où elle se révèle au point de vue de la morale, comme règle des actions humaines.

Dépouiller les principaux acteurs, si sympathiques, si séduisants qu'ils soient, de leurs paillettes, de leurs oripeaux, de leurs toges, de leur sceptre même ; les réduire à la taille, à la condition de simples mortels, sujets comme nous aux lois inexorables de la justice et de l'humanité ; leur distribuer éloge ou blâme selon la dictée d'une froide équité, n'est-ce pas introduire un changement complet dans la mise en scène, et, pour bien des personnages, substituer la vérité aux mirages trompeurs du passé qui les entouraient ?

Appliquer l'histoire à la politique, c'est-à-dire juger à ce point de vue les actions des hommes, est un principe vieux comme le monde.

Il arrachait, il y a deux mille ans, à un illustre Romain, l'exclamation connue : *Discite justitiam et non temnere Divos.* Soyez justes et respectez la divinité.

Ce cri de la conscience humaine revendiquant ses droits, souvent poussé, si souvent méconnu pendant le long crépuscule du paganisme, ne l'a-t-il pas été également pendant l'ère vantée de la civilisation moderne ?

Bien des cœurs généreux parmi les historiens se sont cependant insurgés contre l'idée de l'injustice triomphante. Plusieurs n'ont pas craint de marquer au fer rouge les turpitudes du crime en haut lieu.

Jamais je n'oublierai l'impression profonde que me fit, lorsque j'étais bien jeune encore, la lecture du volume du savant académicien Etienne Jouy, "*La morale appliquée à la politique,*" aussi bien que les éloquentes dénonciations du grand historien Archibald Alison, stigmatisant les monstres de cruauté qui souillèrent le sol français pendant la révolution de 1789.

LA DISPERSION PROJETÉE DES HABITANTS DE LA NOUVELLE-YORK, 1689.

On était en 1689 ; l'astre de Louis XIV avait atteint son apogée ; une aurore radieuse lui avait assuré des jours sereins ; mais le crépuscule menaçait de se faire — lui apportant ses ombres.

Le prince d'Orange, son implacable ennemi, venait de gravir les marches du trône de la Grande-Bretagne.

Versailles, il est vrai, n'avait pas cessé d'éblouir le monde par l'éclat de ses fêtes, de ses richesses artistiques. Trois fois par semaine, dans des soirées d'un éclat sans pareil, Louis le Grand, s'étalait magnifiquement au milieu de sa cour, dans son féerique palais, dans ses salons fastueux, dits salles de l'*Abondance*, de *Vénus*, de *Diane*, de *Mars*, de *Minerve*, d'*Apollon ;* mais, il semblait moins enjoué, quelquefois même préoccupé, se mêlait moins aux brillants groupes de grands seigneurs, aux essaims de jolies femmes, aux cercles d'hommes de lettres ; son front était soucieux ; il consacrait plus d'heures à son cabinet de travail et à ses ministres.

Il y avait un coin de ses Etats où son astre n'avait pas le même éclat. Cette contrée, c'était la France nouvelle d'au-delà des mers, pour laquelle il avait tant fait. De ce lointain pays, il ne lui venait que bruits sinistres, rumeurs de guerre avec les indigènes, avec les colonies anglaises voisines. Ses forts étaient saccagés, sa colonie chérie ravagée par le féroce, l'insaisissable Iroquois.

Les dépêches de Denonville devenaient de jour en jour plus sombres, alarmantes même, bien que la nouvelle du terrible massacre, à Lachine, près de Montréal, le 4 août 1689, n'eût pas encore traversé l'océan.

Pour rétablir son prestige, il lui fallait frapper un grand coup. Le chevalier de Callières, qui commandait en second sous le marquis de Denonville, lui prépara un plan de campagne à la fois neuf et audacieux. Le roi l'adopta avec des modifications.[1]

Il ne s'agissait de rien moins que de la conquête et de la dispersion de la colonie anglaise avoisinante : Manhatte, sur l'Hudson, la Nouvelle-York, comme elle fut nommée plus tard.

Au dire de Callières, la chose était facile : la force militaire au Canada suffisait, avec l'aide de deux vaisseaux de guerre, pour coopérer sur les rives de l'Atlantique, c'est-à-dire 1,600 hommes, dont 1,000 de troupes régulières et 600 miliciens.

L'armée traverserait en pirogues et en bateaux le lac Champlain et le lac George, s'emparerait d'abord d'Albany, puis descendrait le cours de l'Hudson, et tomberait à l'improviste sur la Nouvelle-York, bourgade d'à peu près 200 hommes en état de porter les armes.

[1] Empruntons à un document officiel le texte même des instructions envoyées par le roi de France à son brave lieutenant, le comte de Frontenac, en juin 1689 : "Si parmy les habitans de la Nouvelle York, il se trouve des Catholiques de la fidélité desquels il croye se pouvoir asseurer, il pourra les laisser dans leurs habitations après leur avoir fait prester serment de fidélité à Sa Majesté.... Il pourra aussi garder, s'il le juge à propos, des artisans et autres gens de service nécessaires pour la culture des terres ou pour travailler aux fortifications en qualité de prisonniers.... Il faut retenir en prison les officiers et les principaux habitans desquels on pourra retirer des rançons. A l'esgard de tous les autres estrangers (*ceux qui ne sont pas Français*), hommes, femmes et enfans, sa Majesté trouve à propos qu'ils soient mis hors de la Colonie et envoyez à la Nouvelle Angleterre, à la Pennsylvanie, ou en d'autres endroits qu'il jugera à propos, par mer ou par terre, ensemble ou séparément, le tout suivant qu'il trouvera plus seur pour les dissiper et empêscher qu'en se se réunissant ils ne puissent donner occasion à des entreprises de la part des ennemis contre cette Colonie. Il envoyera en France les Français fugitifs qu'il y pourra trouver, et, particulièrement ceux de la Religion Prétendue Réformée." *Mémoire pour servir d'Instruction à Monsieur le Comte de Frontenac sur l'Entreprise de la Nouvelle York*, 7 juin, 1689.

Pour les détails de l'attaque sur New-York, consulter les dépêches : *Le Roy à Denonville*, 7 juin 1689 ; *Le Ministre à Denonville*, même date ; *Le Ministre à Frontenac*, même date ; *Ordre du Roy à Vaudreuil*, même date ; *Le Roy au Sieur de la Caffinière*, même date ; *Champigny au Ministre*, 16 novembre, 1689, etc.

Les vaisseaux de guerre en croisière à l'entrée du port attendraient l'arrivée des troupes de terre et leur prêteraient main forte.

La campagne ne durerait au plus qu'un mois ; elle promettait d'importants résultats. D'abord les Anglais seraient écrasés et ne seraient plus à même de fournir, comme par le passé, des armes aux implacables ennemis des Canadiens, aux Iroquois ; ensuite, New-York aux mains des Français, on aurait accès par eau en toutes saisons, et une entrée au Canada plus commode que le Saint-Laurent ; finalement, la chute de la Nouvelle-York, n'entraînerait-elle pas plus tard celle des colonies anglaises de la Nouvelle-Angleterre ? On l'espérait.

Aux velléités de conquête de Louis XIV se mêlaient des sentiments qui font peu d'honneur à ce grand prince : la cruauté envers les vaincus et l'intolérance en matière de croyance religieuse.

Il y avait, en 1689, en France, un homme de guerre capable de se charger de l'exécution de cet étrange projet : l'ancien vice-roi du Canada, le brave vieux comte de Frontenac. Louis XIV s'adressa à lui.

L'énergique septuagénaire fit voile en août pour le Canada, avec deux frégates ; c'était deux mois trop tard.

Le roi lui-même prépara les instructions que Frontenac devait suivre, après la prise de la Nouvelle-York.

On lui enjoignit de disperser aux quatre vents la colonie anglaise ; de la détruire de fond en comble ; de séparer, s'il le fallait, et déporter les familles ; d'emprisonner et rançonner ceux qui refuseraient de renier leur foi ; de confisquer leurs biens au profit de la couronne ; de réduire les ouvriers et gens de métier à la condition de forçats, et les obliger de travailler aux fortifications, si le commandant de l'expédition le jugeait à propos ; de saccager le territoire de la Nouvelle-Angleterre, voisin du Canada, et de prélever des contributions sur les territoires plus éloignés.

Plusieurs causes contribuèrent à faire échouer l'entreprise des Français contre la Nouvelle-York.

D'abord d'interminables retards dans l'équipement des deux frégates armées pour cette expédition ; puis, des tempêtes et des vents contraires sur l'océan, qui prolongèrent tellement la durée de la traversée, que la saison fut jugée trop avancée, à l'arrivée des vaisseaux, pour songer à mettre en marche l'armée de terre.

L'affreux massacre de Lachine, la présence des Iroquois sur la frontière, la nécessité de protéger la colonie contre une nouvelle irruption de ces barbares, ainsi que d'autres causes firent ajourner à d'autres temps le projet criminel du grand monarque. New-York fut laissé à sa destinée.

Le massacre de Glencoe, 1692.

Le mode sommaire prescrit par Louis XIV pour se débarrasser de voisins incommodes, en 1689, produisit ses fruits quelques années plus tard, en 1692. Un souverain voisin sut même renchérir sur son procédé.

Guillaume d'Orange, appelé en 1688 au trône des Stuart, avait lui aussi de mauvais voisins, des sujets incommodes. D'abord les Irlandais : son armée les eût bientôt mis à la raison.

Il avait encore dans son royaume d'autres voisins — des sujets encore plus incommodes et tout aussi impraticables : les montagnards d'Ecosse.

Au sein des ravins et des sombres vallées de la Calédonie, vivait depuis plusieurs siècles un peuple qui n'avait rien de commun avec les populations environnantes. Pauvres, illettrés, vindicatifs, mais athlétiques et endurcis à la fatigue et au combat, les montagnards d'Ecosse, impatients de tout frein, avaient en partage un sol ingrat, presque stérile. Ils ensemençaient d'avoine quelques rares arpents de terre, vivaient de chasse, de pêche, etc. De petits chevaux nommés *shelties*, quelques maigres brebis, de grands bœufs encore plus sauvages que leurs maîtres, tel était le patrimoine, les ressources que les clans d'Ecosse ou tribus se transmettaient de génération en génération. Une noble qualité sociale, cependant, était encore vivace parmi ces farouches habitants des bruyères : une hospitalité large et affectueuse.

Le fier *highlander* ne ressemblait nullement au paisible habitant des plaines, immiscé dans le commerce et l'agriculture.

Il en résultait des rixes fréquentes entre les deux classes qui habitaient ce pittoresque pays, — un état de guerre presque chronique.

Il y avait de plus entre les divers clans des rancunes inextinguibles. Ainsi les Campbell et les MacDonald étaient d'ordinaire à couteaux tirés, avec le grand MacCallum More (le duc d'Argyle). Les MacLeod, les MacPherson, les MacNeil, les MacGregor avaient aussi chacun leur sujet de guerre ; des *vendetta* de famille dignes de la Corse se transmettaient religieusement parmi ces farouches populations qui ne connaissaient d'autre loi que celle du plus fort, d'autre arbitre que la claymore.

Les Ecossais des plaines — *lowlanders* — étaient presque tous presbytériens, tandis que leurs fiers voisins des montagnes, s'ils professaient un culte quelconque, se disaient catholiques romains.

Les belliqueux "fils du brouillard" ou *children of the mist*, comme on les nommait, se distinguaient aussi des *lowlanders*, ou habitants des plaines, par leurs habitudes de déprédations.

Sur le chapitre du bien d'autrui, leurs idées étaient passablement communistes : les troupeaux, les récoltes, les denrées même des *lowlanders* et des *sassenachs* ou Anglais d'au-delà de la Tweed, voilà sur quoi ils comptaient pour suppléer à ce qu'une avare nature avait refusé à leur sol comme moyen de subsistance.

Rob Roy, un montagnard type immortalisé par Walter Scott, résumait en deux lignes leur *credo* social :

> " They should take who have the power,
> " And they should keep who can."

Rien d'étonnant si l'on se plaignait d'eux comme voisins.

Guillaume de Hollande, tout grand capitaine qu'il était, voyant qu'il lui était presque impossible d'atteindre les repaires de ces intraitables populations, conçut l'idée de se prévaloir de leur misère et d'acheter leur fidélité avec de l'or britannique. Douze à quinze mille louis eussent suffi. Ce projet échoua. Macaulay ajoute : "Avec un peu d'or on eût pu épargner des flots de sang."

Trois grands seigneurs se disputaient la préséance en Ecosse, le duc d'Argyle (MacCallum More), le comte de Breadalbane, son cousin, et sir John Dalrymple, mieux connu sous le nom de *Master of Stair*.

C'est surtout la sinistre influence de cet habile homme d'Etat qui est responsable de l'affreuse boucherie que nous allons décrire.

Dans le but de pacifier les *highlands*, le roi d'Angleterre lança d'Edimbourg, une proclamation dans laquelle il ordonnait à ses sujets écossais de se soumettre, promettant amnistie entière aux rebelles qui prêteraient serment de fidélité jusqu'au 31 décembre 1691 inclusivement, et dans laquelle il dénonçait à la vindicte des lois comme traîtres et rebelles ceux qui refuseraient ou négligeraient de se soumettre à cette injonction.

Les préparatifs militaires qui accompagnaient cette proclamation alarmèrent les clans ; tous ou presque tous se hâtèrent de donner leur adhésion avant le terme fixé ; tous, excepté le clan des MacDonald de Glencoe. La fierté du chef de ce clan, MacIan, lui fit ajourner à la dernière heure ce qu'il eût dû faire tout d'abord.

MacIan remit donc au 31 décembre 1691, son voyage pour se faire assermenter, lui et ses vassaux. Quand il se présenta au fort William et demanda qu'on lui fit prêter le serment requis, il découvrit à sa surprise que l'officier de ce poste, le major Hill, n'était pas magistrat, et qu'il lui faudrait aller à Inverary pour être assermenté.

On était en plein hiver ; les routes étaient encombrées de neige ; le trajet dura six jours. Muni d'une lettre de recommandation du major Hill, il se présenta devant le shérif d'Argylshire, le 6 janvier, 1692. Le shérif hésita longtemps, alléguant que ses pouvoirs étaient limités par les termes de la proclamation royale, qu'il n'osait assermenter un rebelle qui n'avait jugé à propos de se soumettre qu'après l'expiration du terme fixé par la proclamation. Enfin, le shérif se rendit aux vives instances de MacIan, et l'assermenta. Il lui remit, pour présentation au conseil d'Edimbourg, un certificat spécial expliquant le retard.

Le bruit que MacIan ne s'était pas soumis dans le temps voulu parvint bientôt aux oreilles des trois grands seigneurs d'Ecosse, alors à la cour du roi Guillaume : Argyle, Breadalbane et Stair, tous trois hostiles aux MacDonald.

Ils en ressentirent une secrète et sinistre joie. Enfin, ils avaient donc une excellente occasion de se venger de leurs mortels ennemis, les MacDonald de Glencoe !

En anéantissant ce repaire de brigands, Stair aurait en sus la satisfaction et la gloire d'inaugurer toute une révolution sociale en Ecosse. Macaulay, l'habile panégyriste de Guillaume III, a soin de mettre tout l'odieux de ce complot à la charge de ses ministres et de ses conseillers ; puis, il en prend occasion pour rappeler une série d'atrocités commises par les MacDonald. Il en est qui semblent à peine croyables.

L'histoire du clan, ajoute-t-il, malgré des exagérations et des légendes, était un tissu de massacres et d'assassinats. On répétait que les MacDonald, de Glengary, pour quelque affront qu'ils avaient subi du peuple de Culloden, en cernèrent l'église un dimanche, et, après en avoir fermé les portes, brûlèrent vifs tous les paroissiens qui s'y trouvaient assemblés. Pendant l'incendie, le musicien attitré de ces meurtriers imitait par dérision, sur sa cornemuse, les cris de désespoir des victimes. Un parti de MacGregor, ayant coupé la tête à un ennemi, lui remplirent la bouche de pain et de fromage, déposèrent cette tête sanglante, sur une table en face de la sœur de la victime, et eurent la joie sauvage de voir cette pauvre femme perdre l'esprit, par l'horreur que lui causa ce sanglant spectacle.

On porta ensuite ce hideux trophée en triomphe au chef. Le clan se réunit dans une ancienne église ; chacun porta la main sur le crâne de la personne assassinée, et jura de

protéger les assassins. Les habitants d'Eigg auraient capturé quelques MacLeod, puis, après les avoir liés pieds et poings, les auraient lâchés à la dérive dans une pirogue, pour devenir le jouet des flots ou périr de faim.

Les MacLeod se seraient vengés en renfermant la population d'Eigg en une caverne, et en allumant à l'entrée un brasier qui consuma hommes, femmes et enfants.

Pour avoir divulgué les auteurs d'un crime, un homme fut lié à un arbre, puis poignardé ; le vieux chef du clan lui aurait donné le premier coup de poignard. La foule aurait ensuite suivi l'exemple du chef, chacun lui enfonçant son poignard dans le corps.

Le *Master of Stair* en était arrivé à la conclusion qu'il fallait traiter comme des bêtes fauves ce ramas de bandits. Homme de lettres, homme d'Etat, profond jurisconsulte, il ne fut pas embarrassé de puiser dans l'histoire des précédents pour justifier ses actes.

Stair haïssait les clans, moins parce qu'ils étaient partisans de la dynastie déçue — les Stuart — que parce qu'il les considérait comme les ennemis irréconciliables de la loi, du commerce, de l'industrie.

La destruction, non seulement des MacDonald, mais de bien d'autres clans qui ne valaient pas mieux, signifiait la perte d'au-delà de 6,000 personnes.

On a de Stair une lettre contenant ses instructions aux troupes chargées de la triste mission dont il sera question plus tard ; cette lettre est d'un calme et d'une concision terribles : " Vos troupes, y est-il dit, ruineront en entier le pays de Lochaber, les terres de Lochiel, de Keppoch, de Glengarry, de Glencoe. Vous serez revêtus de pouvoirs suffisamment étendus. J'espère que les soldats n'embarrasseront pas le gouvernement de prisonniers."

A peine cette sanguinaire missive eut-elle été expédiée, que la nouvelle se répandit à Londres que tous les clans, hors celui de MacDonald de Glencoe, avaient fait leur soumission au roi ; désappointement pour Stair.

Restait encore néanmoins un clan en révolte ; mais un obstacle s'opposait à la froide vengeance de Stair. MacIan, le chef des MacDonald, avait réellement prêté le serment voulu, bien que subséquemment au terme fixé par la proclamation royale.

Par une ténébreuse intrigue ourdie probablement par Stair, le certificat du shérif d'Argyle constatant la prestation du serment fut supprimé ; s'il fut communiqué privément au père du *Master of Stair*, président du conseil d'Edimbourg, il ne fut jamais soumis officiellement au conseil.

Stair, Breadalbane, Argyle ayant, dit Macaulay, comploté la perte des MacDonald, ils n'avaient plus qu'à remplir la formalité de s'abriter derrière la sanction royale.

Il fallait donc avoir un ordre signé du roi Guillaume. On avait fait au roi des peintures si sombres de ces montagnards, que le prince anglais, déjà prévenu contre eux, se persuada facilement — s'il y réfléchit du tout — que c'était une bonne occasion de mettre un terme aux déprédations dont tant de personnes se plaignaient.

Guillaume signa le fatal warrant. " Il signa, dit Burnet, mais sans lire l'ordre qu'on lui présenta." Il était conçu comme suit : " Quant à MacIan de Glencoe et cette tribu, si l'on peut la séparer clairement des autres montagnards, il serait convenable, dans l'intérêt de la loi, d'extirper ce ramassis de bandits ?

Je vous ferai grâce des nombreux motifs invoqués pour atténuer cette atroce sentence, que Macaulay prête à son héros Guillaume III, afin de le laver de ce crime odieux.

Macaulay, comme d'ordinaire, abonde en raisons spécieuses sinon convaincantes, et fournit un plaidoyer fort brillant, plein d'éloquence.

Mais hâtons-nous d'en venir à la catastrophe.

Si l'on eût agi ouvertement et employé la main armée pour détruire les MacDonald, le mode eût au moins trouvé des apologistes ; l'histoire avait des précédents tout prêts. Mais c'est précisément ce qu'il n'eût pas été sage d'entreprendre. La force était impuissante contre ces rapaces renards des highlands blottis dans leurs inaccessibles tanières. On eut donc recours à la ruse, à la trahison.

Le 1er février 1692, cent vingt troupiers du régiment d'Argyle, commandés par un capitaine Campbell et un lieutenant Lindsay, se dirigèrent sur Glencoe.

Lindsay était bien dans son rôle : un front d'airain, une hypocrisie consommée, un cœur inaccessible à la pitié, l'avaient désigné à l'autorité.

Ses relations de famille avec MacIan lui avaient donné de rares facilités pour s'introduire parmi les MacDonald : sa nièce avait épousé Alexandre, le fils du grand chef.

L'arrivée des habits rouges avait d'abord inspiré de l'alarme, que le lieutenant Lindsay dissipa en affirmant que les troupes n'étaient stationnées dans les environs que pour y prendre leurs quartiers d'hiver. On les reçut à bras ouverts ; on l'hébergea lui et sa troupe dans le hameau.

Les MacDonald, avec cette hospitalité proverbiale qui distingue les clans d'Ecosse, mirent leurs chaumières aussi bien que leurs provisions de bouche à la disposition des troupes anglaises ; les officiers étaient cordialement reçus comme hôtes, admis sous le toit domestique des chefs, partageant avec eux les joies, la vie intime de famille. Les longues soirées d'hiver s'écoulaient agréablement au coin du feu de tourbe. On s'y livrait aux amusements du temps. La partie de cartes même n'était pas oubliée, dit Macaulay.

La perfidie poursuivait sa course tortueuse. Le capitaine Campbell montrait une affection particulière pour la nièce du chef, ainsi que pour son mari. Chaque matin il allait chez eux réclamer le traditionnel coup d'appétit — un verre d'eau-de-vie de France — don peut-être du dernier des Stuart. Ses relations lui fournirent les moyens de tout voir, de bien épier les sentiers de la forêt qui pourraient faciliter la fuite des victimes, lorsque le signal du massacre serait donné.

Il faisait rapport de jour en jour à son chef, le lieutenant-colonel Hamilton, qui devait plus tard le rejoindre et lui prêter main forte à la tête d'un détachement de 400 soldats, choisis à dessein dans le clan Campbell, les ennemis mortels des MacDonald.

Hamilton avait fixé la date de la boucherie au 13 février, à cinq heures avant le jour. A cinq heures précises, ce 13 février, le capitaine Campbell avec ses 120 séïdes devait égorger tous les Macdonald de Glencoe âgés de moins de soixante-dix ans, hommes, femmes et enfants.

La veille, Campbell et Lindsay avaient soupé et joué une partie de cartes chez ceux qu'ils avaient mission de massacrer quelques heures plus tard.

L'histoire raconte que pendant cette nuit d'horreur les soldats se lamentaient et murmuraient. "Rencontrer les MacDonald sur le champ de bataille, c'est bien ! s'écrie un soldat, mais les surprendre et les égorger dans leurs lits, cela me répugne." "Notre devoir est d'obéir, lui répond un camarade ; s'il y a mal en ceci, c'est à nos chefs à en porter la responsabilité."

A cinq heures du matin, Hamilton, retardé par l'état des routes, n'était pas encore arrivé ; les ordres de Campbell étaient péremptoires, et la boucherie commença.

Inverrigen, qui hébergeait Campbell, et neuf autres MacDonald furent pris à l'improviste, liés et assassinés. Un enfant de douze ans, enlaçant de ses bras les genoux de Campbell, demanda en sanglotant qu'on l'épargnât. Campbell allait fléchir, mais une brute ayant nom Drummond brûla la cervelle à l'enfant.

Un chef du nom d'Auchintriater, qui s'était levé de bonne heure ce matin-là, et qui était assis avec sa famille composée de huit personnes autour de son feu, essuya une décharge de mousqueterie qui l'abattit avec sept de ses enfants ; son frère s'évada et se cacha dans la forêt.

Lindsay étant allé frapper amicalement à la porte du grand chef MacIan, ce dernier, sans rien soupçonner, lui ouvrit la porte et reçut une balle dans la tête. Ses deux serviteurs furent égorgés, et sa vieille épouse, alors vêtue avec la rude magnificence due à son rang, se vit dépouillée et assaillie par la soldatesque effrénée. Un troupier, tenté par une bague qu'elle avait au doigt, et ne pouvant la lui enlever, lui déchira la chair avec ses dents. Elle expira le lendemain.

Bien que le guet-apens eût été préparé avec une habileté consommée, l'arrivée tardive du lieutenant-colonel Hamilton et de ses 400 soldats, et surtout l'erreur capitale des égorgeurs, qui s'en remirent à leurs armes à feu, au lieu d'employer le poignard, qui fait son œuvre sans bruit, firent manquer en grande partie le sanguinaire complot.

Les habitants de cinquante chaumières, alarmés par les décharges de mousqueterie, avaient pris les sentiers glacés des montagnes. Le fils du chef MacIan, éveillé par ses fidèles serviteurs, au moment même où vingt soldats allaient le cerner, s'évada.

On compta à peu près trente cadavres, y compris ceux de deux femmes. Ce qui fit frissonner d'horreur les bouchers mêmes, ce fut la main d'un petit enfant que l'on ramassa, tranchée sans doute dans le tumulte.

Un seul MacDonald avait survécu ; mais, comme il était âgé de plus de soixante-dix ans, on avait cru que son grand âge le protégerait ; Hamilton le massacra froidement.

On mit le feu au hameau ; puis les troupes se mirent en marche, conduisant avec elles des troupeaux de moutons, des chèvres, neuf cents bœufs et vaches, et deux cents petits chevaux ou ponies écossais.

Combien de fuyards trouvèrent la mort dans les neiges des montagnes ?

Combien de pauvres mères avec leurs enfants à la mamelle blanchirent la plaine de leurs os ou servirent de pâture aux oiseaux de proie ? Qui le saura ?

Après le départ des soldats, plusieurs des survivants revinrent contempler les cendres et les décombres de leurs demeures, et donner la sépulture aux cadavres de leurs proches.

La tradition raconte que le barde du clan escalada un rocher voisin du lieu du sinistre, et de ce point élevé, exhala ses poignantes lamentations sur ses frères égorgés et sur leurs demeures incendiées.

Quatre-vingts ans plus tard, le peuple de cette morne vallée de Glencoe, répétait encore ce lai funèbre.

Voilà une des pages les plus sombres des annales de la Grande-Bretagne ; et, si l'odieux de cette hécatombe doit retomber surtout sur le *Master of Stair*, le comte de Breadalbane et le duc d'Argyle, est-ce que la mémoire du souverain anglais Guillaume III, tout illustre capitaine qu'il a été, est exempte de souillure ?

Avant de signer l'ordre fatal, n'eût-il pas dû se renseigner et du mode que l'on prendrait pour "extirper les bandits" dont on avait à se plaindre, et du nombre des coupables ?

La dispersion des Acadiens — 1755.

Voilà un problème d'histoire bien digne assurément de fixer l'attention de cette Société, mais dont la solution finale, selon nous, devra être ajournée jusqu'au moment où nos archives pourront s'enrichir des documents que l'historien Parkman a eu l'inappréciable avantage de consulter à l'étranger, et qui forment la base de son brillant récit.[1]

Le travail sérieux le plus récent sur cette question est celui de M. Parkman. Nous tâcherons de l'analyser, en y mêlant nos propres commentaires, et sans nous croire tenu d'accepter toutes ses conclusions.

Il en est peu parmi nous qui ignorent les détails de la dispersion des Acadiens. Ce qui, selon moi, est moins connu, ce sont les circonstances qui la précédèrent.

La proscription par voies de fait, ou la suppression des faibles nationalités par la dispersion, n'était pas, comme je viens de le faire voir, un fait inouï dans les annales de la France et de l'Angleterre. Le duel à mort pour la possession de la partie nord de ce continent, qui se continua près d'un siècle entre ces deux puissances, faisait pressentir que l'extermination des premiers habitants du sol, d'abord, puis l'anéantissement de colonies entières, deviendraient aux yeux des souverains des deux pays des éventualités fort possibles, désirables même. Point important à constater.

Ce sont donc les causes et les circonstances qui inspirèrent ce lugubre coup de théâtre, que je me propose d'exposer succinctement en ce travail. Je laisse à dessein de nombreuses lacunes à combler, un champ vaste que mon savant collègue, M. Casgrain[2] saura exploiter avec son habileté bien connue.

"Le conflit en Acadie, dit Parkman, possède un sombre intérêt, puisqu'il se termina par une catastrophe que la prose et la poésie ont commémorée, mais dont les causes ont été incomprises."

L'Acadie, c'est-à-dire, la péninsule de la Nouvelle-Ecosse avec l'addition, selon la prétention des Anglais, de ce que constitue présentement le Nouveau-Brunswick, fut conquise par le général Nicholson, en 1710, et formellement cédée par la France à la couronne anglaise, trois années plus tard, par le traité d'Utrecht.

Par ce traité "il fut expressément stipulé, que ceux des habitants français, qui désirent y demeurer et d'être sujets du royaume de la Grande-Bretagne, devront avoir la libre jouissance de leur religion, selon le rite de l'Eglise romaine, en autant que les lois de la Grande-Bretagne le permettent," mais que ceux qui désireraient émigrer, pourraient le faire avec leurs effets, pourvu qu'ils émigrassent dans l'année. On prétend même que la reine Anne aurait étendu indéfiniment cette période.

Peu de colons se prévalurent de ce droit d'émigrer dans l'année, et, ce terme expiré, ceux qui restaient furent requis de prêter serment d'allégeance au roi George II. Il n'est pas douteux, ajoute Parkman, qu'avec un peu de temps, ils se fussent soumis, si on ne les

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[1] *Montcalm and Wolfe.* Boston, 1884.

[2] M. l'abbé H. R. Casgrain devait traiter un autre côté du sujet, à la même séance, dans son intéressante étude intitulée : *Un pèlerinage au pays d'Evangeline.*

eût pas troublés ; mais les autorités françaises du Canada et du Cap-Breton firent de leur mieux pour les en empêcher, et employèrent des agents pour entretenir leurs sentiments d'hostilité contre l'Angleterre.

Les commandants anglais, à Annapolis, eurent plus d'une fois raison de soupçonner que les attaques dirigées contre eux par les sauvages, étaient inspirées par les Français. Ce ne fut que dix-sept ans après le traité que les Acadiens se déterminèrent à prêter le serment, sous des réserves qui le rendaient presque illusoire. Enfin, vers 1730, la plupart des habitants, ne sachant écrire, apposaient leur croix à un serment [1] qui reconnaissait George II, souverain de l'Acadie, lui promettant fidélité et obéissance. La tranquillité régna jusqu'en 1745. La guerre éclata cette année-là. Une partie des Acadiens restèrent neutres, tandis que d'autres prirent les armes contre les Anglais, et que plusieurs fournirent aux ennemis de ces derniers des renseignements et des provisions. La puissance de l'Angleterre en Acadie, défendue seulement jusque alors par une faible garnison à Annapolis et un détachement encore plus faible à Canceau, s'accrut vers ce temps d'une manière notable. Louisbourg, pris par les Anglais pendant la guerre, avait été restitué par un traité. Les Français se préparèrent de suite à convertir cette ville en une redoutable station navale et militaire.

Le cabinet anglais, pour contrecarrer cette mesure, se mit à l'œuvre et créa une autre station.

On choisit le havre de Chibouctou, sur la plage sud de l'Acadie.

En juin 1749, une flotte de transports anglais, y jeta l'ancre, chargée d'au moins 2,500 immigrants, des ouvriers, des gens de métier, des laboureurs, des soldats, des matelots, des officiers licenciés à la clôture de la guerre et séduits par les offres de terres que leur faisait le gouvernement anglais dans le nouveau monde. C'était une colonie créée par le roi lui-même. Edward Cornwallis, oncle de lord Cornwallis, qui servit plus tard en Amérique, fut nommé gouverneur et commandant en chef de la colonie. On assigna aux colons des lots de terre ; on traça des rues ; on bâtit ; puis, on entoura le tout de palissades, et avant l'hiver on eût pu voir la ci-devant garnison anglaise de Louisbourg monter la garde autour de ces remparts improvisés en bois. En 1752, la nouvelle colonie avait atteint le chiffre de 4,000 âmes et plus. Ainsi naquit la florissante capitale de la Nouvelle-Ecosse — Halifax. En comptant la faible garnison d'Annapolis et les détachements des petits forts, pour surveiller les Acadiens et les sauvages, Halifax représentait la puissance entière de l'Angleterre dans la péninsule acadienne.

Les Français, toujours chagrins de la perte de l'Acadie, étaient décidés à la reconquérir soit par la force, soit par la diplomatie. La fondation d'Halifax indiquait que ce ne serait pas chose facile, et leur faisait craindre également pour Louisbourg. Il y avait pour la France un point qui ne souffrait pas de contestation. Bien qu'un grand nombre d'Acadiens fussent nés sous le pavillon anglais, depuis 1710, il fallait tâcher de les retenir français dans leurs affections, et leur mettre dans l'esprit qu'ils étaient encore sujets français.

En 1748, on en fixait le chiffre à 8,850 communiants, soit de 12,000 à 13,000 âmes.

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[1] Voici la formule du serment : "Je promets et jure sincèrement, en Foi de Chrétien, que je serai entièrement fidèle et obéirai vraiement à Sa Majesté le roy George Second, que je reconnais pour le souverain seigneur de l'Acadie ou Nouvelle-Ecosse ; ainsi Dieu me soit en aide."

L'émigration en 1752 les avait réduits à 9,000 environ. L'Acadie était divisée en six paroisses : d'abord Annapolis, la plus considérable ; les autres centres étaient Grand-Pré, sur le bassin des Mines ; Pisiquid, maintenant Windsor, et Cobequid, maintenant Truro. Leurs prêtres étaient des missionnaires dépendant du diocèse de Québec. C'étaient aussi leurs magistrats. Ainsi régis au spirituel et au temporel par des sujets français, et français par le cœur, ils représentaient dans cette province anglaise une organisation constamment en désaccord avec elle.

Bien que, par le douzième article du traité d'Utrecht, la France eût solennellement déclaré les Acadiens sujets anglais, le gouvernement français intriguait constamment pour les convertir en ennemis de la puissance anglaise.

L'historien Parkman trouve la preuve de tout cela dans la masse de documents officiels qu'il est allé consulter en France, en Angleterre et dans la Nouvelle-Esosse ; malheureusement ces documents n'existent pas au Canada.

Ce n'est pas que les Acadiens eussent à se plaindre du traitement qu'ils avaient à subir des Anglais. Bien au contraire, la foi des traités avait été respectée. Il est vrai que, de temps à autres, on arrêtait leurs missionnaires, quand ils s'oubliaient jusqu'au point de soulever les populations contre le gouvernement britannique, et qu'on les forçait sous peine de l'exil, de ne rien faire pour nuire aux intérêts du souverain anglais ; le conseil d'Halifax les admonestait et les congédiait.

On était en 1749 ; une seconde génération avait vu le jour ; Halifax venait d'être fondée.

Le gouverneur Cornwallis ne se contenta pas de la formule de l'ancien serment de fidélité et d'obéissance ; car les Acadiens répétaient que l'ancien gouverneur de la province — Phillips — leur avait donné l'assurance que l'on ne les forcerait pas à prendre les armes contre les Français ou les sauvages.

Il est vrai qu'on n'exigea pas d'eux ce service militaire ; que virtuellement ils seraient demeurés neutres, si plusieurs d'entre eux, oublieux de leur serment, ne se fussent joints aux partis de guerre des Français. Ceci induisit Cornwallis à exiger une formule de serment aussi complète que celle que signaient les autres sujets anglais,

De là, grande consternation parmi les Acadiens, qui envoyèrent des délégués à Halifax, mais sans résultat satisfaisant ; ils s'inspiraient en ceci de conseils qui leur venaient de l'étranger.

Boishébert, par l'entremise des missionnaires, les exhorta fortement à refuser de prêter aucun serment d'allégeance formelle au roi de la Grande-Bretagne, les engageant à émigrer à l'île Saint-Jean et autres îles françaises voisines. Louis XV était tenu au courant de tout ce qui se passait, et encourageait en sous main les Acadiens à molester les Anglais, afin de dégoûter ces derniers de leur nouvelle fondation — Halifax.

L'abbé LeLoutre se distingua par ses efforts contre le gouvernement britannique : il prêchait aux Acadiens fidélité à la France, et, au cas de refus, il menaçait les colons de lâcher sur eux ses féroces néophytes, les Micmacs. Tout cependant, à son dire, devait se faire dans l'ombre, afin de ne pas compromettre le gouvernement français.

Cornwallis,[1] irrité de ces menées, écrivit à l'évêque de Québec, se plaignant amèrement de la conduite de ses missionnaires. Il l'informa de plus, que, si cet ordre de choses continuait, les missionnaires en défaut seraient jugés et punis sévèrement.

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[1] *Cornwallis to the Bishop of Quebec*, 1 December, 1749.

Les choses continuant d'aller de mal en pis; un malheureux incident vint encore aigrir les esprits: ce fut l'assassinat, par les Micmacs, alliés des Français, d'un officier anglais de distinction, le capitaine Edward Howe, au moment où, sous la protection d'un drapeau blanc, il s'avançait vers les Français comme parlementaire.

Puis, vint la discussion, à Paris, de la question des limites du Canada, entre le roi de France et le roi d'Angleterre. Après trois années de débats, les commissaires nommés par les deux couronnes ne purent en venir à aucune solution satisfaisante.

Le traité d'Utrecht donnait, il est vrai, l'Acadie à l'Angleterre ; mais en quoi consistait l'Acadie ?

Un grand nombre d'Acadiens, dociles aux conseils des Français, s'étaient retirés au fort Beauséjour, où flottait le drapeau de la France ; d'autres avaient émigré aux possessions françaises avoisinantes: le Cap-Breton, l'île Saint-Jean, à proximité suffisante pour prendre part à un moment donné, à l'invasion de l'Acadie anglaise. Leurs compatriotes qui étaient demeurés sous le pavillon britannique, en comptant les Acadiens des Mines et de la vallée de la rivière Annapolis et de quelques autres établissements moindres, pouvaient fournir un total excédant tant soit peu 9,000 âmes. Ils n'avaient pas à se plaindre de leurs maîtres, qui ne les maltraitaient pas dans leurs possessions ; pour ne pas avoir émigré, ils n'étaient pas davantage des loyaux sujets du roi George II.

La nouvelle interprétation du traité d'Utrecht, par la France, lui accordant plus de la moitié de la péninsule acadienne et la presque totalité de la population française, hâta la marche des événements, bien que ce territoire eût été en la possession de l'Angleterre depuis plus de quarante ans.

La France, selon les idées du temps, pouvait en entreprendre la conquête par la voie des armes.

L'Angleterre, de son côté, réclamait beaucoup plus de territoire qu'elle n'en occupait alors.

Du côté de la France, une invasion de l'Acadie était probable.

Le roi de France, qui avait encouragé les pauvres Acadiens à résister à l'Angleterre, était, en honneur, tenu de leur prêter main forte dans leur soulèvement projeté.

La perte de l'Acadie nuisait beaucoup à la puissance et au prestige de la France au Canada. L'Acadie était un trait d'union entre le Canada et la forteresse de Louisbourg ; son sol fertile, sa colonie de laboureurs industrieux, fourniraient en temps de guerre des provisions de bouche aux garnisons et aux troupes françaises ; ses havres serviraient de stations navales pour menacer les colonies anglaises avoisinantes. Chez le militaire anglais, on disait qu'une escadre française chargée de troupes dans la baie de Fundy, serait le signal d'un soulèvement général des Acadiens du bassin des Mines et de la vallée d'Annapolis, aussi bien que des autres populations françaises.

Les chances de réussite d'une telle invasion étaient bonnes. Québec et Louisbourg enverraient des secours aux Acadiens, lesquels avec leurs sauvages alliés seraient en moyen d'opposer une armée supérieure en nombre à celle que Halifax et le petit fort délabré d'Annapolis pourraient réunir pour aider l'Angleterre. Le fort français Beauséjour était une menace perpétuelle pour les Anglais, qui avaient raison de s'alarmer, comme il est facile de s'en convaincre en référant aux lettres échangées entre le gouverneur du Canada, le marquis de Duquesne et le commandant du fort Beauséjour.

Lawrence, le gouverneur de la Nouvelle-Ecosse, était désireux de chasser les colons

français établis en cette province. La France se servait de ces pauvres Acadiens comme de dociles instruments pour pousser ses projets ambitieux, comme des jouets de ses caprices et de sa politique vacillante, sans toutefois leur accorder même un seul régiment comme renforts. Impuissants à servir activement leur ancienne patrie, les Acadiens étaient devenus un embarras permanent pour l'Angleterre.

La prise par Lawrence et Sherley, aidés des milices de la Nouvelle-Angleterre, du fort Beauséjour où commandait de Vergor, et du fort Gaspereau où commandait de Villerai, par Winslow, préludait à l'expulsion complète des Français hors de la péninsule ; néanmoins les forces à la disposition de l'Angleterre étaient si faibles, qu'il leur serait impossible de tenir tête aux Acadiens, s'ils se réunissaient tous aux détachements français et aux sauvages ; comme ils refusaient de prêter le serment de fidélité, le gouverneur de la Nouvelle-Ecosse refusait de compter sur eux.

Les Acadiens, bien qu'ils eussent pour habitude de se dire "neutres", n'étaient en réalité que des ennemis campés au cœur d'une province conquise par l'Angleterre.

Le gouverneur Lawrence, enhardi par les succès récents des armes anglaises, à Beauséjour et à Gaspereau, crut le moment favorable pour exiger des Acadiens, sans distinction, un serment de fidélité sans réserve aucune.

Ils refusèrent formellement de le prêter. Le général anglais paraît avoir agi de la sorte sur sa propre responsabilité et quant à ce qui s'en suivit, sans les ordres de son souverain.

L'armée, de suite, organisa dans le plus parfait secret, son terrible projet de proscription.

Vendredi, le 5 septembre 1755, se consomma le lugubre drame, sinon avec toutes les circonstances atroces que la poésie et la légende ont trouvé utile d'inventer, du moins dans des conditions lamentables à l'extrême.

Un peu plus de 6,000 hommes, femmes et enfants, perfidement parqués à Grand-Pré et ailleurs, furent déposés sur des vaisseaux, déportés et dispersés dans les colonies anglaises, depuis le Massachusetts jusqu'à à la Géorgie. La proscription dans le nouveau monde, rêvée par Louis XIV, se réalisait sous son petit-fils Louis XV.

Il en est qui cherchèrent refuge jusque sous le pavillon français à Québec, et ce ne furent pas les moins malheureux. Des détachements furent dirigés de la Virginie en Angleterre, en France même.

La Nouvelle-Angleterre avait trouvé le moyen d'assouvir sa haine contre le nom français.

Les cruelles formalités que Louis XIV, en 1689, avait prescrites pour disperser et anéantir la colonie anglaise de la Nouvelle-York, qu'il n'avait pu subjuguer, George II les exécuta sur ses sujets acadiens de la Nouvelle-Ecosse ; les pauvres Acadiens avaient commencé par être les instruments de Louis XV, ils finirent par en être les victimes.

Pour les bons et industrieux habitants de Grand-Pré, coupables d'avoir trop aimé une patrie ingrate, il y aura, Messieurs, comme pour bien d'autres nationalités, une renaissance, une réhabilitation devant le tribunal d'une impartiale postérité.

Messieurs, en vous soumettant ce résumé de trois incidents historiques fort connus, je me suis borné à vous signaler les motifs et les circonstances qui les ont inspirés. A vous de les juger.

Vous aurez, ou je me trompe fort, une note de censure à apposer à chacun. Louis

XIV, inspiré par l'intolérance religieuse autant que par la politique, n'échappera pas à la sentence de votre tribunal, bien que les circonstances l'aient empêché de donner suite au projet atroce qu'il avait formé contre la colonie anglaise et hollandaise de la Nouvelle-York.

Vous aurez également à décider du degré de culpabilité du roi George II pour avoir laissé disperser d'une manière si cruelle, en 1755, la colonie française en Acadie, conquise en 1710, — du degré de culpabilité du colonel Lawrence, — et du rôle de la Nouvelle-Angleterre dans ce triste drame.

Mais surtout vous jugerez sévèrement, j'espère, malgré ses éloquents apologistes, le grand prince anglais, Guillaume d'Orange, pour avoir autorisé le hideux massacre de Glencoe, et cela avec une perfidie peu ordinaire.

Puis vous avouerez avec moi, n'est-ce pas ? que les peuples ont dans leurs annales, chacun, des pages sombres qu'ils aimeraient à désavouer.

N.B. — Le lecteur curieux d'approfondir la question de la dispersion des Acadiens, telle que l'a traitée l'historien Frs Parkman, est invité à lire les deux chapitres IV et VIII dans *Montcalm et Wolfe*, vol. I, pp. 90-122 et 234-284.

ROYAL SOCIETY OF CANADA.

TRANSACTIONS

SECTION II.

ENGLISH LITERATURE, HISTORY, ARCHÆOLOGY, ETC.

PAPERS FOR 1886.

I.—*The Right Hand and Left-handedness.*

By DANIEL WILSON, LL.D., F.R.S.E., President of University College, Toronto.

(Read May 25, 1886.)

The hand of man is one of his most distinctive characteristics. Without it he would be, for all practical purposes, inferior to many other animals. It is the executive portion of the upper limb whereby the limits of his capacity as "the tool-user" are determined. As such, it is the essential seat of the primary sense of touch, the organ of the will, the instrument which works harmoniously with brain and heart, and by means of which imagination and idealism are translated into fact. Without it, man's intellectual superiority would be to a large extent unavailable. In its combination of strength with delicacy, it is an index of character in all its variations in man and woman from childhood to old age. It marks the refinement of high civilisation, no less than the dexterity and force of the skilled inventor and mechanician. In the art of the true portrait painter, as in works of Titian and Vandyke, the hand is no less replete with individuality than the face. The unpremeditated action of the orator harmonizes with his utterance; and at times the movements of his hands are scarcely less expressive than his tongue.

It is not necessary to discuss the purely anatomical relations of the human hand to to the fore-limb of other animals; for, if the conclusions here set forth are correct, the special attribute now under discussion is not necessarily limited to man. But the practical distinction lies in the fact that the most highly developed anthropoid, while in a sense four-handed, has no such delicate instrument of manipulation as that which distinguishes man from all other animals. In most monkeys there is a separate and movable thumb in all the four limbs. The characteristic whereby their hallux, or great toe, instead of being parallel with the others, and so adapted for standing and walking errect, has the power of action of a thumb, gives the prehensile character of a hand to the hind limb. This is not confined to the arboreal apes. It is found in the baboons and others that are mainly terrestrial in their habits, and employ the four limbs ordinarily in moving on the ground.

Cuvier's determination of a separate order for man as bimanous has been challenged. Man is, indeed, still admitted to form a single genus, *Homo;* but, in the levelling process of scientific revolution he has been relegated to a place in the same order with the monkeys and, possibly, the lemurs, which in the development of the thumb are more man-like than the apes. In reality, looking simply to man as thus compared with the highest anthropoid apes, the order of *Quadrumana* is more open to challenge than that of the *Bimana.* The hind-limb of the ape approaches anatomically much more to the human foot than the hand; while the fore-limb is a true, though inferior, hand. The ape's hind-limb is indeed prehensile, as is the foot of man in some small degree; but alike anatomi-

cally and physiologically the fore-limb of the ape, like the hand of man, is the prehensile organ *par excellence;* while the primary function of the hind-limb is locomotion.

There are, unquestionably, traces of prehensile capacity in the human foot; and even of remarkable adaptability to certain functions of the hand. Well-known cases have occurred, of persons born without hands, or early deprived of them, learning to use their feet in many delicate operations, including not only the employment of pen and pencil, but the use of scissors, with a facility which still more strikingly indicates the separate action of the great toe, and its thumb-like apposition to the others. In 1882 I witnessed, in the Museum at Antwerp, an artist without arms, who skilfully used his brushes with his right foot. He employed it with great ease, arranging his materials, opening his box of colours, and "handling" his brush, seemingly with a dexterity fully equal to that of his more favoured rivals. At an earlier date, during a visit to Boston, I had an opportunity of observing a woman, labouring under similar disadvantages, execute elaborate pieces of scissor-work, and write not only with neatness, but with great rapidity. Nevertheless the human foot, in its perfect natural development, is not a hand. The small size of the toes, as compared with the fingers, and the position and movements of the great toe, alike point to diverse functions and a greatly more limited range of action. But the latent capacity of the system of muscles of the foot—scarcely less elaborate than that of the hand, —is obscured to us by the rigid restraints of the modern shoe. The power of voluntary action in the toes manifests itself not only in cases where early mutilation, or malformation at birth, compels the substitution of the foot for the hand; but among savages, where the unshackled foot is in constant use in climbing, and feeling its way through brake and jungle, the free use of the toes, and the power of separating the great toe from the others, are retained, in the same way as may be seen in the involuntary movements of a healthy child. A brief experience of the soft, yielding deerskin moccasin of the Red Indian, in place of the rigid shoe, restores even to the unpractised foot of the white man a freedom of action in the toes, a discriminating sense of touch, and a capacity for grasping rock or tree in walking or climbing, of which he has had no previous conception. The Australian picks up his spear with the naked foot; and the moccasin of the American Indian scarcely diminishes the like capacity to take hold of a stick or stone. The Hindu tailor, in like manner, sits on the ground holding the cloth tightly stretched with his toes, while both hands are engaged in the work of the needle.

Such facts justify the biologist in regarding this element of structural difference between man and the apes as inadequate for the determination of a specific zoological classification. Nevertheless man still stands apart as the tool-maker, the tool-user, the manipulator. A comparison between the fore and hind limbs of the Chimpanzee, or other ape, leaves the observer in doubt whether to name both alike hands or feet, both being locomotive as well as prehensile organs; whereas the difference between the hand and foot of man is obvious, and points to essentially diverse functions. The short, weak thumb, the long, nearly uniform fingers, and the inferior play of the wrist, in the monkey, are in no degree to be regarded as defects. They are advantageous to the tree-climber, and pertain to its hand as an organ of locomotion; whereas the absence of such qualities in the human hand secures its permanent delicacy of touch, and its general adaptation for all manipulative purposes.

The human hand is thus eminently adapted to be the instrument for carrying out the

purposes of intelligent volition. It is the necessary concomitant of man's intellectual development, not only enabling him to fashion all needful tools, and to contend successfully with the fiercest and most powerful animals, provided by nature with formidable weapons of assault, but also to respond to every mental prompting in the most delicate artistic creations. The very arts of the ingenious nest-makers, the instinctive weavers or builders, the spider, the bee, the ant, or the beaver, place them in striking contrast to man in relation to his handiwork. He alone, in the strict sense of the term, is a manufacturer. The Quadrumana, though next to man in the approximation of their fore-limbs to hands, claim no place among the instinctive architects, weavers, or spinners. The human hand, as an instrument of constructive design, or artistic skill, ranks wholly apart from all the organs employed in the production of analogous work among the lower animals. The hand of the ape accomplishes nothing akin to the masonry of the swallow, or the damming and building of the beaver. But, imperfect though it seems, it suffices for all requirements of the forest-dweller. In climbing trees, in gathering and shelling nuts or pods, opening shell-fish, tearing off the rind of fruit, or pulling up roots, in picking out thorns or burs from its own fur, or in the favourite occupation of hunting for each other's parasites, the monkey uses the finger and thumb; and in many other operations, performs with the hand what is executed by the quadruped or bird less effectually by means of the mouth or bill. At first sight, we might be tempted to assume that the quadrumanous mammal had the advantage of us; as there are, certainly, many occasions when an extra hand could be turned to useful account. But not only do man's two hands prove greatly more serviceable for all higher purposes of manipulation than the four hands of the ape; but as he rises in the scale of intellectual superiority, he seems as it were to widen still further this difference in proportionate manipulative appliance, by converting one hand into the special organ and servant of his will; while the other is relegated to a subordinate place, as its mere aider and supplement.

There is thus a progressive scale, from the imperfect to the more perfectly developed, and then to the perfectly educated hand—all steps in its adaptation to the higher purposes of the manipulator. The hand of the rude savage, of the sailor, the miner, or blacksmith, while well fitted for the work to which it is applied, is a very different instrument from that of the chacer, engraver, or cameo-cutter; of the musician, painter or sculptor. This difference is unquestionably a result of development, whatever the other may be; for, as we have in the ascending scale the civilised and educated man, so also we have the educated hand as one of the most characteristic features of civilisation. But here attention is at once called to the distinctive preference of the right hand, whether as the natural use of this more perfect organ of manipulation, or as an acquired result of civilisation. The phenomenon to be explained is not merely why each individual uses one hand rather than another. Experience abundantly accounts for this. But if, as seems to be the case, all nations, civilised and savage, appear from remotest times to have used the same hand, it is vain to look for the origin of this as an acquired habit. Only by referring it to some anatomical cause can its general prevalence, among all races, and in every age, be satisfactorily accounted for. Nevertheless this simple phenomenon, cognisant to the experience of all, and brought under constant notice in our daily intercourse with others, seems to baffle the physiologist in his search for any entirely satisfactory explanation.

To the quaint speculative fancy of Sir Thomas Browne, with his strong bent towards Platonic mysticism, this question, like other and higher speculations with which he dallied, presented itself in relation to what may well be called, "first principles," as an undetermined problem. "Whether," says he in his "Religio Medici," "Eve was framed out of the left side of Adam, I dispute not, because I stand not yet assured which is the right side of a man, or whether there be any such distinction in nature." That there is a right side in man is a postulate not likely to be seriously disputed; but whether there is such a distinction in nature remains still unsettled, two centuries and a half after he thus started the question. The proofs, nevertheless, are varied, and at least on this broad aspect of the question, as it seems to me, conclusive. The evidence which language supplies leaves no room to doubt the prevalence of the habit of using one specific hand for all actions requiring either unusual force or special delicacy; and will be found to coincide with still older proofs furnished by the implements and the drawings of prehistoric times. Even among races in the rudest condition of savage life, such as the Australians, and the Pacific Islanders, terms for "right", the "right hand", or approximate expressions, show that the distinction is no product of civilisation. In the Kamilarai dialect of the Australians bordering on Hunter's River and Lake Maquarie, *matara* signifies "hand", but they have the terms *turovn*, right, on the right hand, and *ngorangón*, on the left hand. In the Wiraturai dialect of the Wellington Valley, the same ideas are expressed by the words *bumalgál* and *miraga*, dextrorsum and sinistrorsum.

The idea lying at the root of our own decimal notation, which has long since been noted by Lepsius, Donaldson and other philologists, as the source of names of Greek and Latin numerals, is no less discernible in the rudest savage tongues. Among the South Australians the simple names for numerals are limited to two, viz., *ryup*, one, and *politi*, two; the two together express "three"; *politi-politi*, four; and then "five" is indicated by the term *ryup-murnangin*, *i. e.*, one hand; ten by *politi-murnangin*, *i. e.*, two hands. The same idea is apparent in the dialects of Hawaii, Raratonga, Viti, and New Zealand, in the use of the one term: *lima*, *rima*, *linga*, *ringa*, etc., for hand and for the number 5. *Fulu*, and its equivalents, stand for "ten", apparently from the root *fu*, whole, altogether; while the word *tau*, which in the Hawaian signifies "ready", in the Tahitian "right, proper," and in the New Zealand, "expert, dextrous," is the common Polynesian term for the right hand. In the Vitian language, as spoken in various dialects throughout the Viti or Fiji Islands, the distinction is still more explicitly indicated. There is first the common term *linga*, the hand, or arm; then the ceremonial term *daka*, employed exclusively in speaking of that of a chief, but which, it may be presumed, also expresses the right hand; as, while there is no other word for it, a distinct term *sema* is the left hand. The root *se* is found not only in the Viti, but also in the Samoa, Tonga, Mangariva, and New Zealand dialects, signifying "to err, to mistake, to wander;" *semo*, unstable, unfixed; while there is the word *matau*, right, dexter, clearly proving the recognition of the distinction. In the case of the Viti, or Fijian, this is the more noticeable, as there appears to be some reason for believing that left-handedness is unusually prevalent among the native of the Fiji Islands. In 1876 a correspondent of "the Times" communicated a series of letters to that journal, in which he embodied anthropological notes on the Fijians, obtained both from his own observations during repeated visits to the Islands, and from conversation with English, American, and German settlers, at the port of call, and on the route between

San Francisco and the Australian Colonies. "The Fijians," he says, "are quite equal in stature to white men; they are better developed relatively in the chest and arms than in the lower limbs; they are excellent swimmers, and, if trained, are good rowers. Left-handed men are more common among them than among white people; three were pointed out in one little village near the anchorage." Yet here, as elsewhere, it is exceptional.

The evidence of the recognition of native right-handedness reappears in widely separated islands of the Pacific. The Samoan word *lima*, hand, also signifying "five"; and the terms *lima maira*, right hand, and *lima woat*, left-hand, are used as the equivalents of our own mode of expression. But also the left-hand is *lima tau-anga-vale*, literally, the hand that takes hold foolishly. In the case of the Samoans, it may be added, as well as among the natives of New Britain, and other of the Pacific Islands, the favoured hand corresponds with our right hand. My informant, the Rev. George Brown, for fourteen years a missionary in Polynesia, states that the distinction of right and left hand is as marked as among Europeans; and left-handedness is altogether exceptional. In the Terawan language, which is spoken throughout the group of islands on the equator called the Kingsmill Archipelago, the terms *atai* or *edai*, right, dexter, (entirely distinct from *rapa*, good, right,) and *maan*, left, sinister, are applied to *bai*, or *pai*, the hand, to denote the difference, e. g., *te bai maan*, the left hand, literally, the "dirty hand," that which is not used in eating. The languages of our American continent furnish similar evidence of the recognition of the distinction among its hunter-tribes. In the Chippeway the word for my "right-hand" is *ne-keche-neenj*, *ne* being the prenominal prefix, literally "my great hand." "My left-hand" is *ne-nuh-munje-neenj-ne*. *Numunj* is the same root as appears in *nuh-munj-e-doon*, "I do not know"; and the idea obviously is "the uncertain, or unreliable hand." Again, in the Mohawk language, "the right-hand" is expressed by the term *ji-ke-we-yen-den-dah-kon*, from *ke-we-yen-deh*, literally, "I know how." *Ji* is a particle conveying the idea of *side*, and the termination *dah-kon* has the meaning of "being accustomed to." It is, therefore, the limb accustomed to act promptly, the dextrous organ. *Ske-ne-kwa-dih* the left-hand, literally means "the other side."

Analogous terms are found alike in the languages of civilised and barbarous races, expressive of the inferiority of one hand in relation to the other, which is indicated in the classical *sinistra* as the subordinate of the *dextra manus*. The honorable significance of the right hand receives special prominence in the most sacred allusions of the Hebrew scriptures; and in medieval art the right hand in benediction is a frequent symbol of the First Person of the Trinity. In the Anglo-Saxon version of the New Testament the equivalent terms appear as *swythre* and *wynstre*, as in Matthew vi. 3: "Sothlice thonne thu thinne aelmessan do, nyte thin wynstre hwaet do thin swythre;" "When thou doest alms, let not thy left hand know what thy right hand doeth." Again the distinction appears in a subsequent passage thus: "And he geset tha scep on hys swithran healfe, and tha tyccenu on hys wynstran healfe." (Matt. xxv. 34.) Here the derivation of *swythre* from *swyth*, strong, powerful, *swythra*, a strong one, a dextrous man, *swythre*, the stronger, the right-hand, is obvious enough. It is also used as an adjective, as in Matthew v. 30: "And gif thin *swytrhe hand* the aswice, aceorf hig of;" "And if thy right hand offend thee, cut it off." The derivation of *wynstre* is less apparent, and can only be referred to its direct significance, *se wynstra*, the left. In the Greek we find the isolated *ἀριστερός*, *ἀριστερά*, left, *ἡ ἀριστερά*,

the left hand. Whatever etymology we adopt for this word, the depreciatory comparison between the left and the more favoured δεξιά, or right-hand, is obvious enough in the σκαιός, the left, the ill-omened, the unlucky; σκαιότης, left-handedness, awkwardness; like the French *gauche*, awkward, clumsy, uncouth. The Greek had also the term derived from the left arm as the shield-bearer; hence ἐπ' ἀσπίδα, on the left, or shield side.

The Gaelic has supplied to Lowland Scotland the term *ker*, or carry-handed, in common use, derived from *lamh-chearr*, the left hand. In the secondary meanings attached to *ker*, or carry, it signifies awkward, devious; and in a moral sense is equivalent to the English use of the word "sinister." To "*gang the kar gate*" is to go the left-road, *i. e.*, the wrong road, or the road to ruin. There is no separate word in the Gaelic for "right hand," but it is called *lamh dheas* and *lamh ceart*. Both words imply "proper, becoming, or right." *Ceart* is the common term to express what is right, correct, or fitting, whereas *dheas* primarily signifies the "south", and is explained by the supposed practice of the Druid augur following the sun in his divinations. In this it will be seen to agree with the secondary meaning of the Hebrew *yamin*, and to present a common analogy with the corresponding Greek and Latin terms, hereafter referred to. *Deisal*, a compound of *dheas*, south, and *iùl*, a guide, a course, is commonly used as an adjective, to express a lucky or favorable occurrence. The "left hand" is variously styled *lamh chli*, the wily or cunning hand, and *lamh cearr*, or *ciotach*. *Cearr* is wrong, unlucky, and *ciotach* is the equivalent of *sinister*, formed from the specific name for the left-hand, *ciotag*, Welsh *chwithig*. According to Pliny,[1] "The Gauls, in their religious rites, contrary to the practice of the Romans, turned to the left." An ancient Scottish tradition traces the surname of Kerr to the fact that the Dalriadic king, Kynach-Ker or Connchad Cearr, as he is called in the "Duan Albanach," was left-handed; though the name is strongly suggestive of a term of reproach like that of the Saxon Ethelred, the Unready.

Milton, in one of his Sonnets, plays in sportive satire with the name of another left-handed Scot, "Colkitto, or Macdonnel, or Galasp." The person referred to under the first name was the Earl of Antrim's deputy, by whom the invasion of Scotland was attempted in 1644, on behalf of the Stuarts. The name is scarcely less strange in its genuine form of Alastair MacCholla-Chiotach; that is, Alexander, son of Coll, the left-handed. This was the elder Macdonnel, of Colonsay, who was noted for his ability to wield his claymore with equal dexterity in the left hand or the right; or, as one tradition affirms, for his skill as a left-handed swordsman after the loss of his right hand: and hence his soubriquet of Colkittock, or Coll, the Left-handed. The term "carry" is frequently used in Scotland as one implying reproach, or contempt. In some parts of the country, and especially in Lanarkshire, it is even regarded as an evil omen to meet a carry-handed person when setting out on a journey. Jamieson notes the interjectional phrase *car-shamye* (Gaelic *sgeamh-aim*, to reproach) as in use in Kinrosshire, in the favourite Scottish game of shintie, when an antagonist takes what is regarded as an undue advantage by using his club, or shintie in the left hand. All this, while indicating the exceptional character of left-handness, clearly points to a habit of such frequent occurrence as to be familiarily present to every mind. But the exceptional skill, or dexterity, as it may be fitly called, which usually pertains to the left-handed operator, is generally sufficient to redeem him from slight. The

[1] Hist. Nat., lib. xxviii. c. 2.

ancient Scottish game of golf, which is only a more refined and strictly regulated form of the rustic shintie, is one in which the implements are of necessity right-handed, and so subject the left-handed player to great disadvantage, unless he provides his own special clubs. The links at Leith have long been famous as an arena for Scottish golfers. King Charles I was engaged in a game of golf there, when, in November, 1641, a letter was delivered into his hands which gave him the first account of the Irish Rebellion. The same links were a favorite resort of his younger son, James II, while still Duke of York, and some curious traditions preserve the memory of his relish for the game. There, accordingly, golf is still played with keenest zest; and among its present practisers is a left-handed golfer, who, as usual with left-handed persons, is practically ambidextrous. He has accordingly provided himself with a double set of right and left drivers and irons; so that he can use either hand at pleasure according to the character of the ground or the position of the ball, to the general discomfiture of his one-handed rivals. The Scotchmen of Montreal and Quebec have transplanted the old national game to Canadian soil; and the latter city has a beautiful course on the historical battle-field, the scène of Wolfe's victory and death. There experience induced the Quebec Golf Club, when ordering spare sets of implements for the use of occasional guests from Great Britain, to consider the propriety of providing a left-handed set. In the discussion to which the proposal gave rise, it was urged to be unnecessary, as a left-handed player generally has his own clubs with him; but finally the order was limited to two left-handed drivers, so that when a left-handed golfer joins them he has to put with his driver. The considerateness of the Quebec golfers was no doubt stimulated by the fact that there is a skilled golfer of the Montreal Club whose feats of dexterity as a left-handed player at times startle them. A Quebec golfer writes to me thus: "There is one left-handed fellow belonging to the Montreal Club who comes down occasionally to challenge us; and I have watched his queer play with a good deal of interest and astonishment."

To the left-handed man his right hand is the less ready, the less dexterous, and the weaker member. But in all ordinary experience the idea of weakness, uncertainty, unreliability, attaches to the left hand, and so naturally leads to the tropical significance of "unreliable, untrustworthy," in a moral sense. Both ideas are found alike in barbarous and classic languages. An interesting example of the former occurs in Ovid's "Fasti" (iii. 869), where the poet speaks of the flight of Helle and her brother on the golden-fleeced ram, and describes her as grasping its horn, "with her feeble left hand, when she made of herself a name for the waters," *i. e.*, by falling off and being drowned:—

> "Utque fugam capiant, aries nitidissimus auro
> Traditur. Ille vehit per freta longa duos.
> Dicitur informa cornu tenuisse sinistra
> Femina, cum de se nomina fecit aquæ."

In the depreciatory moral sense, Plautus, in the "Persa" (II. ii. 44) calls the left hand *furtifica*, "thievish." "Estne hæc manus? Ubi illa altera est furtifica læva?" So in like manner the term in all its forms acquires a depreciatory significance, and is even applied to sinister looks. So far, then, as the evidence of language goes, the distinction of the right from the left hand, as the more reliable member, appears to be coeval with the earliest known use of language.

This preferential use of one hand as the more skilful, and hence the more honoured member, at an early stage in the use of weapons of war, or in the apt labours of the husbandman or craftsman, finds confirmation from another line of evidence. The prevalence of a decimal system of numerals among widely severed nations, alike in ancient and modern times, has been universally ascribed to the simple process of counting with the aid of the fingers. Mr. Francis Galton, in his "Narrative of an Exploration in Tropical Africa," when describing the efforts of the Damaras at computation, states that the mental effort fails them beyond *three*. "When they wish to express *four*, they take to their fingers, which are to them as formidable instruments of calculation as a sliding rule is to an English school-boy. They puzzle very much after *five*, because no spare hand remains to grasp and secure the fingers that are required for units." Turning to the line of evidence which this primitive method of computation suggests, some striking analogies reveal a recognition of ideas common to the savage and to the cultivated Greek and Roman. Donaldson, in his "New Cratylus," in seeking to trace the first ten numerals to their primitive roots in Sanskrit, Zend, Greek and Latin, derives seven of them from the three primitive prenominal elements. But *five*, *nine* and *ten* are referred directly to the same infantile source of decimal notation, suggested by the ten fingers, as that which has been recognised in similar operation among the Hawaians and the Maoris of New Zealand. "One would fancy, indeed, without any particular investigation of the subject, that the number *five* would have some connection with the word signifying 'a hand', and the number *ten* with a word denoting the 'right hand'; for in counting with our fingers we begin with the little finger of the left hand." Hence the familiar idea, as expressed in its simplest form, where Hesoid (Op. 740) calls the hand *πέντοζον*, the five-branch; and hence also *πεμπάζω*, primarily to count on five fingers.

Bopp, adopting the same idea, considers the Sanskrit *pan'-cha* as formed of the copulative conjunction added to the neuter form of *pa*, one, and so signifying "and one." Benary explains it as an abbreviation of *pân'-i-cha*, "and the hand"—the conjunction being equally recognisable in *pan'-cha*, *πέν-τε* and *quin-que*. This, they assume, expressed the idea that the enumerator then began to count with the other hand; but Donaldson ingeniously suggests the simpler meaning, that after counting four, the whole hand was opened and held up. To reckon by the hand was, accordingly, to make a rough computation, as in the "Wasps," of Aristophanes, where Bdelycleon bids his father, the dicast, "first of all calculate roughly, not by pebbles, but *ἀπὸ χειρός*, with the hand."

The relation of *δεξιά* to *δέκ-α* and *dextra*, *δέκ-α*, *decem*, *δεκ-σιός*, *decster*, illustrates the same idea. Grimm, indeed, says, "In counting with the fingers, one naturally begins with the left hand, and so goes on to the right. This may explain why, in different languages, the words for *the left* refer to the root of *five*, those for *the right* to the root of *ten*." Hence also the derivation of finger, through the Gothic, and Old High German, from the stem for "five" and "left"; while the Greek and Latin *δάκτυλος* and *digitus*, are directly traceable to *δέκα* and *decem*. The connexion between *ἀριστερά* and *sinistra* is also traced with little difficulty; the sibilant of the latter being ascribed to an initial digamma, assumed in the archaic form of the parent vocabulary. Nor is the relationship of *δεξιά* with *digitus* a far-fetched one. As the antique custom was to hand the wine from right to left, so it may be presumed that the ancients commenced counting with the left hand, in the use of that primitive abacus, finishing with the dexter or right hand at the tenth digit, and so completing the decimal numeration.

The inferior relation of the left to the right hand was also indicated in the use of the former for lower, and the latter for higher numbers beyond ten. In reckoning with their fingers, both Greeks and Romans counted on the left hand as far as a hundred, then on the right hand to two hundred, and so on alternately, the even numbers being always reckoned on the right hand. The poet Juvenal refers to this, in his tenth Satire, where, in dwelling on the attributes of age, he speaks of the centenarian, "who counts his years on his right hand:"—

> "Felix nimirum, qui tot per secula mortem
> Distulit, atque suos jam dextra computat annos,
> Quique novum toties mustum bibit."

A curious allusion, by Tacitus, in the first book of his History, serves to show that the German barbarians beyond the Alps no less clearly recognised the significance of the right hand, as that which was preferred, and accepted as the more honourable member. The Lingones, a Belgian tribe, had sent presents to the legions, as he narrates; and in accordance with ancient usage, gave as the symbolical emblem of friendship, two right hands clasped together. "Miserat civitas Lingonum vetere instituto dona legionibus, dextras, hospitii insigne." The dextræ are represented on a silver quinarius of Julius Cæsar, thus described in Ackerman's "Catalogue of rare and unedited Roman Coins," "PAX. S. C. Female head. *Rev.* L. AEMILIVS. BVCA. IIII. VIR. Two hands joined."[1]

Other evidence of a different kind confirms the recognition and preferential use of the right hand among our Teutonic ancestors from the remotest period. Dr. Richard Lepsius, in following out an ingenious analysis of the primitive names for the numerals, and the sources of their origin, traces from the common Sanskrit root *daça*, Greek *δέκα*, through the Gothic *taihun*, the *hunda*, as in *tva hunda*, two hundred. He next points out the resemblance between the Gothic *hunda*, and *handus*, i. e. "the hand," showing that this is no accidental agreement, but that the words are etymologically one and the same. The A. S. *hund*, a hundred, originally meant only "ten," and was prefixed to numerals above twenty, as *hund eahtatig*, eighty, etc.

Thus far philological evidence clearly points to a very wide prevalence of the recognition of right-handedness; and when we turn from this to the oldest sources of direct historical evidence, the references abundantly confirm the same conclusions. More than one allusion in the "Book of Judges" show that the skill of the left-handed among the tribe of Benjamin was specially noted; while at the same time, the very form of the record marks the attribute as exceptional; and all the more so as occurring in the tribe whose patronymic—*ben yamin*, the son of the right hand,—so specially indicates the idea of honour and dignity constantly associated with the right hand throughout the Hebrew Scriptures. When, as we read in the "Book of Judges," the Lord raised up a deliverer of Israel from the oppression of Eglon, King of Moab, Ehad, the son of Gera, was a Benjamite, a man left-handed. He accordingly fashioned for himself a two-edged dagger which he girt under his raiment upon his right thigh; and thus armed, he presented himself as the bearer of a present from the children of Israel to the King, and sought a private interview, saying: "I have a secret errand unto thee, O King." The special fitness of the left-

[1] Ackerman i. 106.

handed messenger, in this case, was, it may be presumed, that as he put forth his left hand to take the dagger from his right side, the motion would not excite suspicion. But also, as we learn from a later chapter, a body of seven hundred chosen marksmen, all left-handed, were selected from the same tribe for their preëminent skill. "Everyone could sling stones at a hair breadth and not miss." Nevertheless the relative numbers are not such as to suggest that left-handedness was more common among the tribe of Benjamin than in others of the tribes. Of twenty-six thousand Benjamites that drew the sword, there were the seven hundred left-handed slingers; or barely 2.7 per cent.; which does not greatly differ from the proportion noted at the present time. In the song of triumph for the avenging of Israel over the Canaanites, in the same "Book of Judges," the deed of vengeance by which Sisera, the Captain of the host of Jabin, King of Canaan, perished by the hand of a woman, is thus celebrated:—"She put her hand to the nail, and her right hand to the workman's hammer; and with the hammer she smote Sisera." Here, as we see, while their deliverer from the oppression of the Moabites is noted as a Benjamite, a left-handed man; Jael, the wife of Heber the Kenite, is blessed above women, who with her right hand smote the enemy of God and her people. Along with those references may be noted one of a later date, recorded in the first "Book of Chronicles." When David was in hiding from Saul, at Ziklag, there came to him a company of Saul's bretheren of Benjamin, mighty men, armed with bows, who could use both the right hand and the left in hurling stones and shooting arrows out of a bow. These latter, it will be observed, are noted not as left-handed, but ambidextrous; but this is characteristic of all left-handed persons; though even amongst them the unwonted facility with both hands rarely, if ever, entirely supersedes the greater dexterity of the left hand. Possibly the patronymic of the tribe gave significance to such deviations from normal usage; but either for this, or some unnoted reason, the descendants of Benjamin, the Son of the Right Hand, appear to have obtained notoriety for exceptional aptitude in the use of either hand.

So far it is manifest that the preferential use of one hand specially designated by a term that came to be associated with honour, dignity and trust, was common to many ancient people; and is perpetuated in the languages both of civilised and savage races. But this suggests another inquiry of important significance in the determination of the results. The application of the Latin *dexter* to "right-handedness" specifically, as well as to general dexterity in its more comprehensive sense, points, like the record of the old Benjamites, to the habitual use of one hand in preference to the other; but does it necessarily imply that *their* "right hand" was the one on that side which we now concur in calling dexter or right? In the exigencies of war or the chase, and still more in many of the daily requirements of civilised life, it is necessary that there should be no hesitation as to which hand shall be used. Promptness and dexterity depend on this, and no hesitation is felt. But, still further, in many cases of combined action, it is needful that the hand so used shall be the same; and wherever such a conformity of practice is recognised the hand so used, whichever it be, is that on which *dexterity* depends, and becomes practically the *right* hand. The term *yamin*, "the right hand," already noted as the root of the proper name, Benjamin, and of the tribe thus curiously distinguished for its left-handed warriors and skilled marksmen, is derived from the verb *yāmăn*, to be firm, to be faithful, as the right hand is given as a pledge of fidelity, *e. g.*, "The Lord hath sworn by his right hand" (Isaiah, lxii. 8). So in the Arabic form, *bimin Allah*, by the right hand of Allah.

So also with the Hebrews and other ancient nations, as still among ourselves, the seat at the right hand of the host, or of any dignitary, was the place of honour; as when Solomon "caused a seat to be set for the king's mother; and she sat on his right hand" (1 Kings, ii. 19). Again, the term is frequently used in opposition to *semal*, left hand; as when the children of Israel would pass through Edom; "We will go by the king's highway; we will not turn to the right hand or to the left" (Numbers, xx. 17).

But a further use and significance of the terms helps us to the fact that the Hebrew *yamin* and our *right hand* are the same. In its secondary meaning it signified the "south," as in Ezekiel, xlvii. 1: "The forefront of the house stood toward the east, and the waters came down from under from the right side of the house, at the south side of the altar." The four points are accordingly expressed thus in Hebrew: *yamin*, the right, the south; *kedem*, the front, the east; *semol*, the left, the north; *achor*, behind, the west. To the old Hebrew, when looking to the east, the west was thus behind, the south on his right hand, and the north on his left. This determination of the right and left in relation to the east is not peculiar to the Hebrews. Many nations appear to have designated the south in the same manner, as being on the right hand when looking to the east. Its origin may be traced with little hesitation to the associations with the most ancient and dignified form of false worship, the paying divine honours to the Sun, as he rises in the east, as the Lord of Day. Thus we find in the Sanskrit *dakshina*, right hand, south; *puras*, in front, eastward; *apara*, *paçchima*, behind, west; *uttara*, northern, to the left. The old Irish has, in like manner, *deas* or *ders*, on the right, southward; *oirthear*, in front, east; *jav*, behind, west; *tuath*, north, from *thuaidh*, left. The analogous practise among the Esquimaux, though sugested by a different cause, illustrates a similar origin for the terms "right" and "left." Dr. H. Fink, in a communication to the Anthropological Institute (June, 1885) remarks:—"To indicate the quarters of the globe, the Greenlanders use at once two systems. Besides the ordinary one, they derive another from the view of the open sea, distinguishing what is to the left and to the right hand. The latter appears to have been the original method of determining the bearings, but gradually the words for the left and the right side came to signify at the same time 'south' and 'north'."

A diverse idea is illustrated by the like secondary signifiance of the Greek *σκαιός*, left, or on the left hand; but also used as "west", or "westward", as in the Iliad, iii. 149, *σκαιαὶ πύλαι*, the west gate of Troy. The Greek augur, turning, as he did, his face to the north had the left—the sinister, ill-omened, unlucky side,—on the west. Hence the metaphorical significance of *ἀριστερός*, ominous, boding ill. But the Greeks had also the other mode of expressing the *right* and *left*, derived from their mode of bearing arms. When Carlyle, at the advanced age of seventy-five, lost the use of his right hand, which had for so many years wielded the pen with such marvellous effect on his age, among the reflections which this privation suggested to him, he asks. "Why that particular hand was chosen?" and dubiously answers: "Probably arose in fighting; most important to protect your heart and its adjacencies; and to carry the shield on that hand." Archaic vases suffice to illustrate the mode of carrying the shield among the Greeks and hence, the shield-hand became synonymous with the left. The right side was *ἐπὶ δόρυ*, the spear side, while the left was, *ἐπ' ἀσπίδα*, the shield side. The familiar application of the terms in this sense is seen in Xenophon's "Anabasis" (IV. iii. 26) *Καὶ παρήγγειλε τοῖς λοχαγοῖς κατ' ἐνωμοτίας ποιήσασθαι ἕκαστον τὸν ἑαυτοῦ λόχον, παρ' ἀσπίδας παραγαγόντας τὴν*

ἐνωμοτίαν ἐπὶ φάλαγγος, "He ordered to draw up his century in squads of twenty-five, and post them in line to the left." And again, Anabasis, IV. iii. 29: Τοῖς δὲ παρ' ἑαυτῷ παρήγγειλεν . . . ἀναστρέψαντας ἐπὶ δόρυ, κ.τ.λ., "He ordered his own division, turning to the right." The word ἀριστερός has also been interpreted as "the shield-bearing arm."

Among the Romans, we may trace some survival of the ancient practise of worshipping towards the east, as in Livy, i. 18, where the augurs are said to turn the right side to the south, and the left side to the north. But the original significance of turning to the east had then been lost sight of; and the particular quarter of the heavens towards which the Roman augur was to look appears to have been latterly very much at the will of the augur himself. It was, at any rate, variable. Livy indicates the east; but Varro assigns the south, and Frontinus the west. Probably part of the augur's professional skill consisted in selecting the aspect of the heavens suited to the occasion. But this done, the flight of birds and other appearances on the right or on the left, determined the will of the gods. "Why," asks Cicero, himself an augur, "Why should the raven on the right, and the crow on the left, make a confirmatory augury?" "Cur a dextra corvus, a sinistra cornix faciat ratum?" (De Divin. i.) The left was the side on which the thunder was declared to be heard which confirmed the inauguration of a magistrate, and in other respects the augur regarded it with special awe. But still the right side was, in all ordinary acceptance, the propitious one; as in the address to Hercules (Æn. viii. 302):—

> "Salve, vera Jovis proles, pecus addite divis;
> Et nos et tua dexter adi pede sacra secundo."

The traces of a term of common origin for right (south) in so many of the Indo-European languages is interesting and suggestive; though the ultimate word is still open to question. How the equivalent terms run through the whole system may be seen from the following illustrations: Sanskrit, *dakshina* (cf. *deccan*); Zend, *dashina*; Gothic, *taihs-vo*; O. H. German, *zëso*; Lithuanian, *desziné*; Gaelic, *dheas*; Erse, *dess* (*deas*); Latin, *dexter*; Greek, δεξιός, etc. The immediate Sanskrit stem *daksh* means "to be right, or fitting;" secondarily "to be dexterous, clever," etc. This is evidently from a root, *dek*, as the western languages show. It was usual at an earlier period to trace the whole to the root, *dik*, to show, to point; but this is now given up. Probably the Greek δεκ-ομαὶ (δέχομαι) take, receive, preserves the original stem, with the idea primarily of "seizing, catching." This leads naturally to a comparison of δάκτ-υ-λος, finger, and *dig-i-tus*, δοκ-ά-νη, fork, etc. (see Curtius' "Outlines of Greek Etymology.")

Right-handed usages, and the ideas which they suggest, largely influence the ceremonial observances of many nations, affect their religious observances, bear a significant part in the marriage rites, and are interwoven with the most familiar social usages. Among the ancient Greeks the rites of the social board required the passing of the wine from right to left—or, at any rate, in one invariable direction,—as indicated by Homer in his description of the feast of the gods, (Iliad, i. 597, θεοῖς ἐνδέξια πᾶσιν οἰνοχόει,) where Hephæstus goes round and pours out the sweet nectar to the assembled gods. The direction pursued by the cup-bearer would be determined by his bearing the flagon in his right hand, and so walking with his right side towards the guests. This is, indeed, a point of dispute among scholars. But it is not questioned that a uniform practice prevailed,

dependent on the recognition of right and left-handedness ; and this is no less apparent among the Romans than the Greeks. It is set forth in the most unmusical of Horace's hexameters : "Ille sinistrorsum, hic dextrorsum abit ;" and finds its precise elucidation from many independent sources, in the allusions of the poets, in the works of sculptors, and in decorations of fictile ware. The determination of the actual right and left of the Greeks and Romans, as of other nations, is of importance, in order to ascertain if they were the same as our own. But the true direction of the Hebrew right and left has a special significance, in view of the fact that whilst the great class of Aryan languages, including the ancient Sanskrit, Greek and Latin, appear to have been written from left to right, and the same characteristic is common to the whole alphabets and writings of India : all the Semitic languages, except the Ethiopic, are written from right to left. Habit has so largely affected our current handwriting, and modified its forms into those best adapted for rapid and continuous execution in the one direction, that its reversal at once suggests the idea of a left-handed people. But there is no true ground for this. So long as each character was separately drawn, and when, moreover, they were pictorial or ideographic, it was, in reality, more natural to begin at the right, or nearer side, of the papyrus or tablet, than to pass over to the left. The forms of all written characters are largely affected by their mode of use, as is abundantly illustrated in the transformation of the Egyptian ideographs in the later demotic writing. The forms of the old Semitic alphabet, like the Egyptian hieroglyphics, are specially adapted to cutting on stone. The square Hebrew characters are of much later date ; but they also, like the uncials of early Christian manuscripts, were executed singly, and therefore could be written as easily from right to left as in a reverse order. The oldest alphabets indicate a special adaptation for monumental inscriptions. The Runic characters of northern Europe owe their peculiar form apparently to them being primarily cut on wood. When papyrus leaves were substituted for stone, a change was inevitable ; but the direction of the writing only becomes significant in reference to a current hand. The Greek fashion of *boustrophedon*, or alternating like the course of oxen in ploughing, illustrates the natural process of beginning at the side nearest to the hand ; nor did either this, or the still earlier mode of writing in columns, as with the ancient Egyptians, or the Chinese, present any impediment, so long as it was executed in detached characters. But so soon as the reed or quill, with the coloured pigment, began to supersede the chisel, the hieratic writing assumed a modified form ; and when it passed into the later demotic handwriting, with its seemingly arbitrary script, the same influences were brought into play which control the modern penman in the slope, direction, and force of his stroke. One important exception, however, still remained. Although, as in writing Greek, the tendency towards the adoption of tied letters was inevitable, yet to the last the enchorial or demotic writing was mainly executed in detached characters, and does not, therefore, constitute a true current hand-writing, such as in our own continuous penmanship leaves no room for doubt as to the hand by which it was executed. Any sufficiently ambidextrous penman, attempting to copy a piece of modern current writing with either hand, would determine beyond all question its right-handed execution. But no such certain result is found on applying the same test to the Egyptian demotic. I have tried it on two of the Louvre demotic MSS. and a portion of a Turin papyrus, and find that they can be copied with nearly equal dexterity with either hand. Some of the characters

are more easily and naturally executed, without lifting the pen, with the left hand than the right. Others again, in the slope and the direction of the thickening of the stroke, suggest a right-handed execution, but habit in the forming of the characters, as in writing Greek or Arabic, would speedily overcome any such difficulty either way. I feel assured that no habitually left-handed writer would find any difficulty in acquiring the unmodified demotic hand; whereas no amount of dexterity of the penman compelled to resort to his left hand in executing ordinary current writing suffices to prevent such a modification in the slope, the stroke, and the formation of the characters, as clearly indicates the change.

So soon as the habitual use of the papyrus, with the reed pen and coloured pigments, had developed any uniformity of usage, the customary method of writing by the Egyptian appears to have accorded with that in use among the Hebrew and other Semitic races; though examples do occur of true hieroglyphic papyri written from left to right. But the pictorial character of such writings furnishes another test. It is easier for a right-handed draftsman to draw a profile with the face looking towards the left; and the same influence might be anticipated to affect the direction of the characters incised on the walls of temples and palaces. This has accordingly suggested an available clue to Egyptian right or left-handedness. But the evidence adduced from Egyptian monuments is liable to mislead. A writer in "Nature" (J. S., April 14th, 1870), states as the result of a careful survey of the examples in the British Museum, that the hieroglyphic profiles there generally look to the right, and so suggest the work of a left-handed people. Other and more suggestive evidence from the monuments of Egypt points to the same conclusion, but it is deceptive. The hieroglyphic sculptures of the Egyptians, like the cufic inscriptions in Arabian architecture, are mainly decorative; and are arranged symmetrically for architectural effect. The same principle regulated their introduction on sarcophagi. Of this, examples in the British Museum furnish abundant illustration. On the great sarcophagus of Sebaksi, priest of Phtha, the profiles on the right and left column look towards the centre line; and hence the element of right-handedness is subordinated to decorative requirements. If this is overlooked, the left-handedness ascribed above to the ancient Egyptians may seem to be settled beyond dispute, by numerous representations both of gods and men, engaged in the actual process of writing. Among the incidents introduced in the oft-repeated judgment scene of Osiris—as on the Adytum of the Temple of Dayr el Medineh, of which I have a photograph,—Thoth, the Egyptian God of Letters, stands with the stylus in his left hand, and a papyrus or tablet in his right, and records concerning the deceased, in the presence of the divine judge, the results of the literal weighing in the balance of the deeds done in the body. In other smaller representations of the same scene, Thoth is similarly introduced holding the stylus in his left hand. So also, in the decorations on the wall of the great chamber in the rock-temple of Abou Simbel, Rameses is represented slaying his enemies with a club, which is held in his left hand; and in the sculptures of Pasht, she is decapitating her prisoners with a scimiter, held in the left hand. This evidence seems so direct and indisputable as to settle the question; yet further research leaves no doubt that it is illusory. Ample evidence to the contrary is to be found in Champollion's "Monuments de l'Egypte et de la Nubie"; and is fully confirmed by Maxime Du Camp's "Photographic Pictures of Egypt, Nubia, etc.," by Sir J. Gardner Wilkinson's "Manners and Customs of the Ancient Egyptians," and by other

photographic and pictorial evidence. In a group, for example, photographed by Du Camp, from the exterior of the sanctuary of the palace of Karnak, where the Pharaoh is represented crowned by the ibis and hawk-headed deities, Thoth and Horus, the hieroglyphics are cut on either side so as to look towards the central figure. The same arrangement is repeated in another group at Ipsamboul, engraved by Champollion "Monuments de l'Egypte," (Vol. I. Pl. 5.) Still more, where figures are intermingled. looking in opposite directions—as shown in a photograph of the elaborately sculptured posterior façade of the Great Temple of Denderah,—the accompanying hieroglyphics, graven in column, vary in direction in accordance with that of the figure to which they refer. Columns of hieroglyphics repeatedly occur, separating the seated deity and a worshipper standing before him, and only divided by a perpendicular line, where the characters are turned in opposite directions corresponding to those of the immediately adjacent figures.

When, as in the Judgment scene at El Medineh and elsewhere, Osiris is seated looking to the right, Thoth faces him holding in the off-hand—as more extended, by reason of the simple perspective,—the papyrus or tablet; while the pen or style is held in the near or left hand. To have placed the pen and tablet in the opposite hands, would have required a complex perspective and foreshortening, or would have left the whole action obscure and unsuited for monumental effect. Nevertheless, the difficulty is overcome in repeated examples: as in a repetition of the same scene engraved in Sir J. Gardner Wilkinson's "Manners and Customs of the Ancient Egyptians" (Pl. 88), and on a beautifully executed papyrus, part of "The Book of the Dead," now in the Louvre, and reproduced in facsimile in Sylvestre's "Universal Palæography" (Vol. I. Pl. 46), in both of which Thoth holds the pen or style in the right hand. The latter also includes a shearer holding the sickle in his right hand, and a female sower, with the seed-basket on her left arm, scattering the seed with her right hand. Examples of scribes, stewards, and others engaged in writing, are no less common in the scenes of ordinary life; and though when looking to the left, they are, at times, represented holding the style or pen in the left hand, yet the preponderance of evidence suffices to refer this to the exigencies of primitive perspective. The steward in a sculptured scene from a tomb at Elethya (Monuments de l'Egypt, Pl. 142), receives and writes down a report of the cattle from the field servants, holding the style in his right hand, and the tablet in his left. So is it with the registrar and the scribes (Wilkinson, figs. 85, 86), the steward who takes account of the grain delivered (fig. 387), and the notary and scribes (figs. 73, 78)—all from Thebes, where they superintend the weighing at the public scales, and enumerate a group of negro slaves.

In the colossal sculptures on the façades of the great temples, where complex perspective and foreshortening would interfere with the architectural effect, the hand in which the mace or weapon is held appears to be mainly determined by the direction to which the figure looks. At Ipsamboul, as shown in "Monuments de l'Egypt," Pl 11, Rameses grasps with his right hand, by the hair of the head, a group of captives of various races, negroes included, while he smites them with a scimiter or pole-axe, wielded in his left hand; but an onlooker, turned in the opposite direction, holds the sword in his right hand. This transposition is more markedly shown in two scenes from the same temple (Pl. 28). In the one Rameses, looking to the right, wields the pole-axe in the near or right hand, as he smites a kneeling Asiatic; in the other, where he looks to the left, he holds his weapon again in the near, but now the left hand, as he smites a kneeling negro.

On the same temple soldiers are represented holding spears in the near hand, right or left, according to the direction they are looking (Pl. 22); and swords and shields are transposed in like manner (Pl. 28). The same is seen in the siege scenes and military reviews of Rameses the Great, on the walls of Thebes and elsewhere. The evidence is misleading if the primary aim of architectural decoration is not kept in view. In an example from Karnac—appealed to in proof that the Egyptians were a left-handed people,—where Thotmes III holds his offering in the extended left hand, his right side is stated to be towards the observer. Nor are similar examples rare. Thoth and other deities, sculptured in colossal proportions, on the Grand Temple of Isis, at Philæ, as shown by Du Camp, in like manner have their right sides towards the observer, and hold each the mace or sceptre in the extended left hand. But on turning to the photographs of the Great Temple of Denderah, where another colossal series of deities is represented in precisely the same attitude, but looking in the opposite direction, the official symbols are reversed, and each holds the sceptre in the extended right hand. Numerous similar instances are given by Wilkinson; as in the dedication of the pylon of a temple to Amun by Rameses III, Thebes (No. 470); the Goddesses of the West and East, looking in corresponding directions (No. 461), etc.

Examples, however, occur where the conventional formulæ of Egyptian sculpture have been abandoned, and the artist has overcome the difficulties of perspective; as in a remarkable scene in the Memnonium, at Thebes, where Atmoo, Thoth, and a female (styled by Wilkinson the Goddess of Letters), are all engaged in writing the name of Rameses on the fruit of the Persea tree. Though looking in opposite directions, each holds the pen in the right hand (Wilkinson, Pl. 54 A). So also at Beni Hassan, two artists kneeling in front of a board, face each other, and each paint an animal, holding the brush in the right hand. At Medinet Habou, Thebes, more than one scene of draught-players occurs, where the players, facing each other, each hold the piece in the right hand. Similar illustrations repeatedly occur.

Among another people, of kindred artistic skill, whose records have been brought anew to light in recent years, their monumental evidence appears to furnish more definite results; while proof of a wholly different kind leaves no room to doubt that among them a specific hand was recognised as that which every child learned to prefer as soon as reason assumed its sway. When the prophet had proclaimed the destruction of Nineveh, and resented the Divine mercy to its repentant people which seemed to falsify his message, the lesson taught him by the withering of his gourd is thus set forth: "And should not I spare Nineveh, that great city, wherein are more than six score thousand persons that cannot discern between their right hand and their left?" That the Ninevites and the ancient dwellers on the Euphrates and the Tigris were a right-handed people appears to be borne out by their elaborate sculpture, recovered at Kourjunjik, Khorsabad, Nimroud, and other buried cities of the great plain. The sculptures are in relief, and frequently of a less conventional character than those of the Egyptian monuments, and are consequently less affected by the aspect and position of the figures. The gigantic figure of the Assyrian Hercules—or, as supposed, of the mighty hunter, Nimrod—found between the winged bulls, in the great court of the Palace of Khorsabad, is represented strangling a young lion, which he presses against his chest with his left arm, while he holds in his right hand a weapon of the chase, supposed to be analogous to the Australian boomerang. On

the walls of the same palace the great king appears with his staff in his right hand, while his left hand rests on the pommel of his sword. Behind him a eunuch holds in his right hand, over the king's head, a fan or fly-flapper; and so with other officers in attendance. Soldiers bear their swords and axes in the right hand, and their shields on the left arm. A prisoner is being flayed alive by an operator who holds the knife in the right hand. The king himself puts out the eyes of another captive, holding the spear in his right hand, while he retains in his left the end of a cord attached to his victim. Similar evidence abounds throughout the elaborate series of sculptures in the British Museum and in the Louvre. Everywhere gods and men are represented as "discerning between their right hand and their left," and giving the preference to the former.

It has been already shown that in languages of the American continent, as in those of the Algonquins and the Iroquois, the recognition of the distinction between the right and left hand is apparent; and on turning to the monuments of a native American civilisation, evidence similar to that derived from the sculptures of Egypt and Assyria serves to show that the same hand had the preference in the New World as in the Old. In the Palenque hieroglyphics of Central America, for example, in which human and animal heads frequently occur among the sculptured characters, it is noticeable that they invariably look towards the left, indicating, as it appears to me, that they are the graven inscriptions of a lettered people, who were accustomed to write the same characters from left to right on paper or skins. Indeed, the pictorial groups on the Copan statues seem to be the true hieroglyphic characters; while the Palenque inscriptions correspond to the abbreviated hieratic writing. The direction of the profile was a matter of no moment to the sculptor, but if the scribe held his pen or style in his right hand, like the modern clerk, he would as naturally draw the left profile as the penman slopes his current hand to the right. In the pictorial hieroglyphics, reproduced in Lord Kingsborough's "Mexican Antiquities," as in other illustrations of the arts of Mexico and Central America, it is also apparent that the battle-axe and other weapons and implements are most frequently held in the right hand. But to this exceptions occur; and it is obvious that there, also, the crude perspective of the artist influenced the disposition of the tools, or weapons, according to the action designed to be represented, and the direction in which the actor looked.

Such are some of the indications which seem to point to a uniform usage, in so far as we can recover evidence of the practice among ancient nations. But far behind their most venerable records lie the chronicles of Palæolithic ages: of the men of the drift and of the caves of Europe's prehistoric dawn. "I wonder," says Carlyle, when the deprivation of the use of his right hand forced this enquiry on his special notice, "I wonder if there is any people barbarous enough not to have this distinction of hands; no human Cosmos possible to be even begun without it." It need not, therefore, surprise us that evidence is now adduced which seems to prove that the draftsmen of European's Palæolithic Era gave the preference to the right hand; and that the flint implements of the drift reveal, by the direction of the grooves produced on their surface in the process of flaking, that their manufacturers were also, with rare exceptions, right-handed.

The troglodyte of Europe's Palæolithic dawn has transmitted to us his ingenious works as a draftsman; and in the graphic representations of the mammoth, the reindeer, the fossil horse, and others of the contemporary fauna, which have been preserved through

all the intermediate ages, securely sealed up in the cave breccia, we have illustrations of the hand-usage of primitive times of profounder significance than any that the monuments of Assyria or Egypt supply. Among those there are undoubted left-handed drawings; and above all a remarkably skilful and spirited sketch of a reindeer grazing, recovered from a cave at Thayngen, in the Kesserloch, Schaffhausen. The examples of the art of the Palæolithic draftsmen thus far recovered are too few in number to admit of any general conclusion as to the relative use of the right or left hand among the primitive cave men. There is, indeed, among them a larger percentage of left-handed draftsmen than would ordinarily be looked for as exceptional deviations from the normal practise among a right-handed people. But, without attempting to deduce any statistical results of general application from such narrow premises, the evidence is distinctly in favour of primitive right-handedness.

So far, then, it seems to be proved that not only among cultured and civilised races, but among the barbarous tribes of both hemispheres—in Australia, Polynesia, among the Arctic tribes of our northern hemisphere at the present day, and among the Palæolithic men of Europe's Post-Pliocene times,—not only has a habitual preference been manifested for the use of one hand rather than the other, but among all alike the same hand has been preferred. Yet, also, it is no less noteworthy that this prevailing uniformity of practice has always been accompanied by some very pronounced exceptions. Not only are cases of exceptional facility in the use of both hands of frequent occurrence; but while right-handedness everywhere predominates, left-handedness is nowhere unknown. The skill of the combatant in hitting with both hands is indeed a favourite topic of poetic laudation, though this is characteristic of every well-trained boxer. In the combat between Entellus and Dares (Æn. v. 456), the passionate Entellus strikes, now with his right hand, and again with his left :—

> "Præcipitemque Daren ardens agit æquore toto,
> Nunc dextra ingeminans ictus, nunc ille sinistra."

But the more general duty of the left hand is as the guard, or the shield-bearer, as where Æneas gives the signal to his comrades, in sight of the Trojans (Æn. x. 261)—

> "Stans celsa in puppi; clipeum cum deinde sinistra
> Extulit ardentem."

The right hand may be said to express all active volition and all beneficent action, as in Æn. vi. 370, "Da dextram misero," "Give thy right hand to the wretched," *i. e.*, give him aid; and so in many other examples, all indicative of right-handedness as the rule. The only exception I have been able to discover occurs in a curious passage in the "Eclogues" of Stobæus *Περὶ ψυχῆς*, in a dialogue between Horus and Isis, where, after describing a variety of races of men, and their peculiarities, it thus proceeds: "An indication of this is found in the circumstance that southern races, that is those who dwell on the earth's summit, have fine heads and good hair; eastern races are prompt to battle, and skilled in archery for the right hand is the seat of these qualities. Western races are cautious, and for the most part left-handed; and whilst the activity which other men display belongs to their right side, these races favour the left." Stobæus, the Macedonian, belongs, at

earliest, to the end of the fifth century of our era, but he collected diligently from numerous ancient authors, some of whom would otherwise be unknown ; and here he gives us the only indication of a belief, however vague, in the existence of a left-handed people.

Of the occurrence of individual examples of left-handedness, the proofs are ample, from the earliest times to the present. Professor Hyrtl, of Vienna, affirms its prevalence among the civilised races of Europe in the ratio of only two per cent.; and the number of the old Benjamite left-handed slingers, as distinguished from other members of the band of twenty-six thousand warriors, did not greatly exceed this. In the ruder conditions of society, where combined action is rare, and social habits are less binding, a larger number of exceptions to the prevailing usage may be looked for; as the tendency of a high civilisation must be to diminish its manifestation. But education is powerless to eradicate it where it is strongly manifested in early life. My attention has been long familiarly directed to it from being myself naturally left-handed ; and the experience of considerably more than half a century enables me to controvert the common belief, on which Dr. Humphry founds the deduction that the superiority of the right hand is not congenital, but acquired, viz., that "the left hand may be trained to as great expertness and strength as the right." On the contrary, my experience accords with that of others in whom inveterate left-handedness exists, in showing the education of a lifetime contending with only partial success to overcome an instinctive natural preference. The result has been, as in all similar cases, to make me ambidextrous, yet not strictly speaking ambidexterous.

The importance of this in reference to the question of the source of right-handedness is obvious. Mr. James Shaw, by whom the subject has been brought under the notice of the British Association, and the Anthropological Institute, remarks in a communication to the latter : "Left-handedness is very mysterious. It seems to set itself quite against physiological deductions, and the whole tendency of art and fashion." Dr. John Evans, when commenting on this, and on another paper on "Left-handedness" by Dr. Muirhead, expressed his belief that "the habit of using the left hand in preference to the right, though possibly to some extent connected with the greater supply of blood to one side than the other, is more often the result of the manner in which the individual has been carried in infancy." This reason has been frequently suggested ; but if there were any force in it, the results to be looked for would rather be an alternation of hands from generation to generation. The nurse naturally carries the child on the left arm, with its right side toward her breast. All objects presented to it are thus offered to the free left hand ; and it is accordingly no uncommon remark that all children are at first left-handed. If their training while in the nurse's arms could determine the habit, such is its undoubted tendency; but if so, the left-handed nurses of the next generation would reverse the process. Nevertheless the bias towards a preferential use of either hand varies greatly in degree. The conclusion I am led to, as the result of long observation is that the preferential use of the right hand is natural and instinctive with some persons; that with a smaller number an equally strong impulse is felt prompting to the use of the left hand; but that with the great majority right-handedness is mainly the result of education. If children are watched in the nursery, it will be found that the left hand is offered little less freely than the right. The nurse or mother is constantly transferring the spoon from the left to the right hand, correcting the defective courtesy of the proffered left hand, and in all ways superinducing right-handedness as a habit. As soon as the child is old enough

to be affected by such influences, the fastening of its clothes, the handling of knife and spoon, and of many other objects in daily use, help to confirm the habit, until the art of penmanship is mastered, and with this crowning accomplishment—except in cases of strongly marked bias in an opposite direction,—the left hand is relegated to its very subordinate place as a mere supplementary organ, to be called into use where the privileged member finds occasion for its aid.

But on the other hand, an exaggerated estimate is formed of the difficulties experienced by a left-handed person in many of the ordinary actions of life. It is noted by Mr. James Shaw that the buttons of our dress, and the hooks and eyes of all female attire, are expressly adapted to the right hand. Again, Sir Charles Bell remarks : "We think we may conclude, that everything being adapted, in the conveniences of life, to the right hand, as for example the direction of the worm of the screw, or of the cutting end of the augur, is not arbitrary, but is related to a natural endowment of the body. He who is left-handed is most sensible to the advantages of this adaptation, from the opening of the parlour door to the opening of a penknife." This idea, though widely entertained, is to a large extent founded on misapprehension. It is undoubtedly true that the habitual use of the right hand has controlled the form of many implements, and influenced the arrangements of dress, as well as the social customs of society. The musket is fitted for a habitually right-handed people. So, in like manner, the adze, the plane, the gimlet, the screw and other mechanical tools, must be adapted to one or the other hand. Scissors, snuffers, shears, and other implements specially requiring the action of the thumb and fingers, are all made for the right hand. So also is it with the scythe of the reaper. Not only the lock of the gun, or rifle, but the bayonet and the cartridge-pouch, are made or fitted on the assumption of the right hand being used ; and even many arrangements of the fastenings of the dress are adapted to this habitual preference of the one hand over the other ; so that the reversing of button and buttonhole, or hook and eye, is attended with marked inconvenience. Yet even in this, much of what is due to habit is ascribed to nature. A Canadian friend, familiar in his own earlier years, at an English public school and university, with the game of cricket, tells me that when it was introduced for the first time into Canada within the last thirty-five years, left-handed batters were common in every field ; but the immigration of English cricketers has since led, for the most part, to the prevailing usage of the mother country. It was not that the batters were, as a rule, left-handed ; but that the habit of using the bat on one side or other was in the majority of cases so little influenced by any predisposing bias, that it was readily acquired in either way. But, giving full weight to all that has been stated here as to right-handed implements, what are the legitimate conclusions which it teaches ? No doubt an habitually left-handed people would have reversed all this. But if, with adze, plane, gimlet, and screw, scythe, reaping hook, scissors and snuffers, rifle, bayonet, and all else—even to the handle of the parlour door, and the hooks and buttons of his dress—daily enforcing on the left-handed man a preference for the right hand, he nevertheless persistently adheres to the left hand, the cause of this must lie deeper than a mere habit induced in the nursery.

It is a misapprehension, however, to suppose that the left-handed man labours under any conscious disadvantage from the impediments thus created by the usage of the majority. With rare exceptions, habit so entirely accustoms him to the requisite action,

that he would be no less put out by the sudden reversal of the door-handle, knife-blade, or screw, or the transposition of the buttons on his dress, than the right-handed man. Habit is constantly mistaken for nature. The laws of the road, for example, so universally recognised in England, have become to all as it were a second nature ; and, as the old rhyme says :—

> "If you go to the left, you are sure to go right ;
> If you go to the right, you go wrong."

But throughout Canada and the United States, the reverse is the law ; and the new immigrant, adhering to the usage of the mother country, is sorely perplexed by the persistent wrong-headedness, as it seems, of everyone but himself.

Yet the predominant practice does impress itself on some few implements in a way sufficiently marked to remind the left-handed operator that he is transgressing normal usage. The candle, "our peculiar and household planet !" as Charles Lamb designates it, has well nigh become a thing of the past ; but in the old days of candle-light the snuffers were among the most unmanageable of domestic implements to a left-handed man. They are so peculiarly adapted to the right hand that the impediment can only be overcome by the dextrous shift of inserting the left thumb and finger below instead of above. As to the right-handed adaptation of scissors, it is admitted by others, but I am unconscious of any difficulty that their alteration would remove. "He that has seen three mowers at work," says Carlyle, "one of whom is left-handed, trying to work together, and how impossible it is, has witnessed the simplest form of an impossibility, which but for the distinction of a 'right hand,' would have pervaded all human things." But, although the mower's scythe must be used in a direction in which the left hand is placed at some disadvantage—and a left-handed race of mowers would undoubtedly reverse the scythe—yet even in this the chief impediment is to coöperation. The difficulty to himself is soon overcome. It is his fellow workers who are troubled by his operations. Like the handling of the oar or still more the paddle of a canoe, or the use of the musket or rifle,—so obviously designed for a right-handed marksman,—the difficulty is soon overcome. It is not uncommon to find a left-handed soldier placed on the left of his company when firing. The writer's own experience in drilling as a volunteer was that, after a little practice, he had no difficulty in firing from the right shoulder ; but he never could acquire an equal facility with his companions in unfixing the bayonet and returning it to its sheath.

But, as certain weapons and implements, like the rifle and the scythe, are specially adapted for the prevailing right hand, and some ancient implements have been recovered in confirmation of the antiquity of the bias ; so the inveterate left-handed manipulator at times reinstates himself on an equality with rival workmen who have thus placed him at a disadvantage. Probably the most ancient example of an implement expressly adapted for the right hand is the handle of a bronze sickle, found in 1873 at the lake-dwelling of Möringen, on the Lake of Brienne, Switzerland. Bronze sickles have long been familiar to the archæologist, among the relics of the prehistoric era, known as the Bronze Age ; and their forms are included among the illustrations of Dr. Ferdinand Keller's "Lake Dwellings." But the one now referred to is the first example that has been recovered showing the complete hafted implement. The handle is of yew, and is ingeniously carved so as to lie obliquely to the blade, and allow of its use close to the ground. It is a right-

handed implement, carefully fashioned so as to adapt it to the grasp of a very small hand, and is far more incapable of use by a left-handed shearer than a mower's scythe. Its peculiar form is shown in an illustration which accompanies Dr. Keller's account; and, in noting that the handle is designed for a right-handed person, he adds: "Even in the Stone Age, it has already been noticed that the implements in use at that time were fitted for the right hand only." But, if so, the same adaptability was available for the left-handed workman, wherever no necessity for coöperation required him to conform to the usage of the majority. Instances of left-handed carpenters who have provided themselves with benches adapted to their special use have come under my notice. I am also told of a scythe fitted to the requirements of a left-handed mower, who must have been content to work alone; and reference has already been made to sets of golfing drivers and clubs for the convenience of left-handed golfers.

The truly left-handed, equally with the larger percentage of those who may be designated truly right-handed, are exceptionally dextrous; and to the former the idea that the instinctive impulse which influences their preference is a mere acquired habit, traceable mainly to some such bias as the mode of carrying in the nurse's arms in infancy, is utterly untenable. The value of personal experience in determining some of the special points involved in this inquiry is obvious, and will excuse a reference to my own observations, as confirmed by a comparison with those of others equally affected, such as Professor Edward S. Morse, Dr. R. A. Reeve, a former pupil of my own, and my friend, Dr. John Rae, the Arctic explorer. The last remarked in a letter to me, confirming the idea of hereditary transmission: "Your case as to left-handedness seems very like my own. My mother was left-handed, and very neat-handed also. My father had a crooked little finger on the left-hand. So have I." Referring to personal experience, I may note as common to myself with other thoroughly left-handed persons, that, with an instinctive preference for the left-hand, which equally resisted remonstrance, proffered rewards, and coercion, I nevertheless learned to use the pen in the right-hand, apparently with no greater effort than other boys who pass through the preliminary stages of the art of penmanship. In this way the right hand was thoroughly educated, but the preferential instinct remained. The slate-pencil, the chalk, and pen-knife, were still invariably used in the left hand, in spite of much opposition on the part of teachers; and in later years, when a taste for drawing has been cultivated with some degree of success, the pencil and brush are nearly always used in the left hand. At a comparatively early age the awkwardness of using the spoon and knife at table, in the left hand, was perceived and overcome. Yet even now, when much fatigued, or on occasion of any unusual difficulty in carving a joint, the knife is instinctively transferred to the left hand. Alike in every case where unusual force is required, as in driving a large nail, wielding a heavy tool, or striking a blow with the fist, and in any operation demanding unusual delicacy, the left hand is employed. Thus, for example, though the pen is invariably used in the right hand in penmanship, the crow-quill and etching needle are no less uniformly employed in the left hand. Hence, accordingly, on proceeding to apply the test of the hand to the demotic writing of the Egytians, by copying rapidly the Turin enchorial papyrus already referred to, first with the right hand and then with the left, while some of the characters were more accurately rendered as to slope, thickening of lines, and curve, with the one hand, and some with the other, I found it difficult to decide on the whole which

hand executed the transcription with greatest ease. In proof of the general facility thus acquired, I may add that I find no difficulty in drawing at the same time, with a pencil in each hand, profiles of men or animals facing each other. The attempt to draw different objects, as a dog's head with the one hand and a human profile with the other, is unsuccessful, owing to the complex mental operation involved; and in this case the coöperation is apt to be between the mind and the more facile hand. In the simultaneous drawing of reverse profiles, there is what, to an ordinary observer, would appear to be thorough ambidexterity. Nevertheless, while there is in such cases of ambidexterity, characteristic of most left-handed persons, little less command of the right hand than in those exclusively right-handed, it is wholly acquired ; nor, in my own experience, has the habit of considerably more than half a century overcome the preferential use of the other hand.

When attending the meeting of the American Association for the Advancement of Science held at Buffalo in 1867, my attention was attracted by the facility with which Professor Edward S. Morse used his left hand when illustrating his communications by crayon drawings on the blackboard. His ability in thus appealing to the eye is well known. The Boston "Evening Transcript," in commenting on a course of lectures delivered there, thus proceeds: "We must not omit to mention the wonderful skill displayed by Professor Morse in his blackboard drawings of illustrations, using either hand with facility, but working chiefly with the left hand. The rapidity, simplicity, and remarkable finish of these drawings elicited the heartiest applause of his audience." Referring to the narrative of my own experience as a naturally left-handed person subjected to the usual right-hand training with pen, pencil, knife, etc., Professor Morse remarks in a letter to me : "I was particularly struck by the description of your experiences in the matter, for they so closely accord with my own : my teachers having in vain endeavoured to break off the use of the left hand, which only resulted in teaching me to use my right hand also. At a short distance, I can toss or throw with the right hand quite as accurately as I can with my left. But when it comes to flinging a stone or other object a long distance, I always use the left hand as coming the most natural. There are two things which I cannot possibly do with my right hand, and that is to drive a nail, or to carve, cut, or whittle. For several years I followed the occupation of mechanical draughtsman, and I may say that there was absolutely no preference in the use of either hand ; and in marking labels, or lettering a plan, one hand was just as correct as the other." I may add here, that in my own case, though habitually using the pen in my right hand, yet when correcting a proof, or engaged in other disconnected writing, especially if using a pencil, I am apt to resort to the left hand without being conscious of the change. In drawing, I rarely use the right hand, and for any specially delicate piece of work, should find it inadequate to the task.

The same facility is illustrated in the varying caligraphy of a letter of Professor Morse in which he furnished me with the best practical illustration of the ambidextrous skill so frequently acquired by the left handed. He thus writes: "You will observe that the first page is written with the right hand, the upper third of this page with the left hand, the usual way [but with reversed slope], the middle third of the page with the left hand, reversed [*i. e.* from right to left], and now I am again writing with the right hand. As I have habitually used the right hand in writing, I write more rapidly than with

the other." In the case of Professor Morse, I may add, the indications of the hereditary transmission of left-handedness nearly correspond with my own. His maternal uncle, and also a cousin, are left-handed. In my case, the same habit appeared in a paternal uncle and a niece; and my grandson, manifested at an early age, a decided preference for the left hand. Even in the absence of such habitual use of both hands as Professor Morse practises, the command of the left hand in the case of a left-handed person is such that very slight effort is necessary to enable him to use the pen freely with it. An apt illustration of this has been communicated to me by the manager of one of the Canadian banks. He had occasion to complain of the letters of one of his local agents as at times troublesome to decipher, and instructed him in certain cases to dictate to a junior clerk who wrote a clear, legible hand. The letters subsequently sent to the manager, though transmitted to him by the same agent, presented in signature, as in all else, a totally different caligraphy. The change of signature led to inquiry; when it turned out that his correspondent was left-handed, and by merely shifting the pen to the more dextrous hand, he was able, with a very little practice, to substitute for the old cramped penmanship, an upright, rounded, neat, and very legible handwriting.

In reference to the question of hereditary transmission, the evidence, as in the case of Dr. Rae, is undoubted. Dr. R. A. Reeve, in whom also the original left-handedness has given place to a nearly equal facility with both hands, informs me that his father was left-handed. Again Dr. Pye-Smith quotes from the "Lancet" of October, 1870, the case of Mr. R. A. Lithgow, who writes to say, that he himself, his father and his grandfather, have all been left-handed. This accords with the statement of M. Ribot in his "Heredity." "There are," he says, "families in which the special use of the left hand is hereditary. Girou mentions a family in which the father, the children, and most of the grandchildren were left-handed. One of the latter betrayed its left-handedness from earliest infancy, nor could it be broken of the habit, though the left hand was bound and swathed." Such persistent left-handedness is not, indeed, rare. In an instance communicated to me, both of the parents of a gentleman in Shropshire were left-handed. His mother, accordingly watched his early manifestations of the same tendency, and employed every available means to counteract it. His left hand was bound up, or tied behind him; and this was persevered in until it was feared that the left arm had been permanently injured. Yet all proved vain. The boy resumed the use of the left hand as soon as the restraint was removed; and, though learning like others, to use his right hand with facility in the use of the pen, and in other cases in which custom enforces compliance with the practise of the majority, he remained inveterately left-handed. Again a Canadian friend, whose sister-in-law is left-handed, thus writes to me: "I never heard of any of the rest of the family who were so; but one of her brothers had much more than the usual facility in using both hands, and in paddling, chopping, etc., used to shift about the implement from one hand to the other in a way which I envied. As to my sister-in-law, she had great advantages from her left-handedness. She was a very good performer on the piano, and her bass was magnificent. If there was a part to be taken only with one hand, she used to take the left as often as the right. But it was at needle-work that I watched her with the greatest interest. If she was cutting out, she used to shift the scissors from one hand to the other; and would have employed the left hand more, were it not that all scissors, as she complained, are made right-handed,

and she wished, if possible, to procure a left-handed pair. So also with the needle, she used the right hand generally; but in many delicate little operations, her habit was to shift it to the left hand."

In these and similar cases, the fact is illustrated that the left-handed person is necessarily ambidextrous. He has the exceptional "dexterity" resulting from the special organic aptitude of the left hand, which is only paralleled in those cases of true right-handedness where a corresponding organic aptitude is innate. Education, enforced by the usage of the majority, begets for him the training of the other and less facile hand; while by an unwise neglect the majority of mankind are content to leave the left hand as an untrained and merely supplementary organ. From the days of the seven hundred chosen men of the tribe of Benjamin, the left-handed have been noted for their skill; and this has been repeatedly manifested by artists. Foremost among such stands Leonardo da Vinci, skilled as musician, painter, and mathematician, and accomplished in all the manly sports of his age. Hans Holbein, Mozzo of Antwerp, Amico Aspertino, and Ludovico Cangiago, were all left-handed, though the two latter are described as working equally well with both hands. In all the fine arts the mastery of both hands is advantageous; and accordingly the left-handed artist, with his congenital skill and his cultivated dexterity, has the advantage of his right-handed rival, instead of—as is frequently assumed—starting at a disadvantage.

It now remains to consider the source to which right-handedness is to be ascribed. Its universal predominance, alike among civilised and savage races, from the earliest prehistoric dawn, altogether precludes the idea that it is a mere habit begot by custom and usage, and developed into a system by education. The bias in which this predominant law of dexterity originated must be traceable to organic structure; but, while the results are so manifest, the source seems thus far to elude research. One anatomical feature in the arrangement of the bodily organs does, indeed, suggest a cause for the preference of the limbs on one side of the body over the other, which would seem to satisfy the requirements in this direction, if accompanied by exceptional deviations from the normal condition corresponding to the occurrence of left-handedness; and in this direction a solution has been mainly sought. The bilateral symmetry of structure, so general in animal life, seems at first sight opposed to any inequality of action in symmetrical organs. But anatomical research reveals the deviation of internal organic structure from such seemingly balanced symmetry. Moreover, right or left-handedness is not limited to the hand, but partially affects the lower limbs, as may be seen in football, skating, in the training of the opera-dancer, etc.; and eminent anatomists and physiologists have affirmed the existence of a greater development throughout the whole right side of the body. Sir Charles Bell says: "The left side is not only the weaker, in regard to muscular strength, but also in its vital or constitutional properties. The development of the organs of action and motion is greatest upon the right side, as may at any time be ascertained by measurement, or the testimony of the tailor or shoemaker." He adds, indeed, "Certainly, this superiority may be said to result from the more frequent exertion of the right hand; but the peculiarity extends to the constitution also, and disease attacks the left extremities more frequently than the right."

With the left-handed, the general vigour and immunity from disease appear to be transferred to that side; and this has naturally suggested the theory of a transposition of

the viscera, and the consequent increase of circulation thereby transferred from the one side to the other. But the relative position of the heart is so easily determined in the living subject, that it is surprising how much force has been attached to this untenable theory by eminent anatomists and physiologists. Another, and more generally favoured idea, traces to the reverse development of the great arteries of the upper limbs a greater flow of blood to the left side; while a third ascribes the greater muscular vigour directly to the supply of nervous force dependent on the early development of the brain on one side or the other.

So far as either line of argument prevails, it inevitably leads to the result that the preference of the right hand is no mere perpetuation of convenient usage, matured into an acquired, or possibly an hereditary habit; but that it is, from the first, traceable to innate physical causes. This, as Sir Charles Bell conceives, receives confirmation from the fact already referred to, that right or left-handedness is not restricted to the hand, but affects the corresponding lower limb, and, as he believes, the whole side; and so he concludes thus: "On the whole, the preference of the right hand is not the effect of habit, but is a natural provision; and is bestowed for a very obvious purpose." Nevertheless, the argument of Sir Charles Bell is, as a whole, vague, and scarcely consistent. He speaks indeed of right-handedness as "a natural endowment of the body," and his reasoning is based on this assumption. But much of it would be equally explicable as the result of adaptations following on an acquired habit. Its full force will come under consideration at a later stage. Meanwhile it is desirable to review the various and conflicting opinions advanced by other inquirers.

The theory of Dr. Barclay, the celebrated anatomist, is thus set forth by Dr. Buchanan, from notes taken by him when a student: "The veins of the left side of the trunk, and of the left inferior extremity, cross the aorta to arrive at the vena cava; and some obstruction to the flow of blood must be produced by the pulsation of that artery." To this Dr. Barclay traced indirectly the preferential use of the right side of the body, and especially of the right hand and foot. "All motions," he stated, "produce obstruction of the circulation; and obstruction from this cause must be more frequently produced in the right side than the left, owing to its being more frequently used. But the venous circulation on the left side is retarded by the pulsation of the aorta, and therefore the more frequent motions of the right side were intended to render the circulation of the two sides uniform." The idea, if correctly reported, is a curious one, as it traces right-handedness to the excess of a compensating force for an assumed inferior circulation pertaining naturally to the right side; and incidentally takes into consideration an abnormal modification affecting the development or relative disposition of organs. Both points have been the subject of more extended consideration by subsequent observers. It is curious, indeed, to notice how physiologists and anatomists have shifted their ground, from time to time, in their attempts at a solution of what has been very summarily dismissed by others as a very simple problem; until, as Dr. Struthers remarks, it "has ceased to attract the notice of physiologists only because it has baffled satisfactory explanation."

The eminent anatomist, Professor Gratiolet, turned from the organs in immediate contact with the arm and hand, and sought for the source of right-handedness in another, and as I incline to think, truer direction; though he only presented a partial view of this aspect of the case. According to Professor Gratiolet, in the early stages of fœtal develop-

ment, the anterior and middle lobes of the brain on the left side are in a more advanced condition than those on the right side, the balance being maintained by an opposite condition of the posterior lobes. Hence, in consequence of the well-known decussation of the nerve-roots, the right side of the body—so far as it is influenced by brain-force,—will, in early fœtal life, be better supplied with nervous force than the left side ; and thereby movements of the right arm would precede and be more perfect than those of the left. But the premises of Gratiolet are disputed ; and even if proved, they must raise further questions, not merely as to the origin, but also as to the influence of such an unequal development of the brain on the action of the limbs.

Dr. Andrew Buchanan, Professor of Physiology in the University of Glasgow, in a paper communicated by him to the Philosophical Society of Glasgow, in 1862, entitled "Mechanical Theory of the predominance of the right hand over the left; or more generally, of the limbs of the right side over those of the left side of the body," aimed at a solution of the question in a new way. According to him, "The preferential use of the right hand is not a congenital, but an acquired attribute of man. It does not exist in the earliest periods of life." Nevertheless, "no training could ever render the left hand of ordinary men equal in strength to the right;" for "it depends upon mechanical laws arising out of the structure of the human body." This theory is thus explained : In infancy and early childhood, there is no difference in power between the two sides of the body ; but so soon as the child becomes capable of bringing the whole muscular force of the body into play, "he becomes conscious of the superior power of his right side, a power not primarily due to any superior force or development of the muscles of that side, but to a purely mechanical cause. He cannot put forth the full strength of his body without first making a deep inspiration; and by making a deep inspiration, and maintaining afterwards the chest in an expanded state, which is essential to the continuance of his muscular effort, he so alters the mechanical relations of the two sides of his body, that the muscles of his right side act with a superior efficacy; and, to render the inequality still greater, the muscles of the left side act with a mechanical disadvantage." Hence the preference for the right side whenever unusual muscular power is required; and, with the greater exercise of the muscles of the right side, their consequent development follows, until the full predominance of the right side is the result.

This theory is based, not merely on the preponderance of the liver and lungs on the right side, but on these further facts: that the right lung is more capacious than the left, having three lobes, while the left has only two; that the liver, the heaviest organ of the body, is on the same side; and that the common centre of gravity of the body shifts, more or less, towards the right, according to the greater or less inspiration of the lungs, and the consequent inclination of the liver resulting from the greater expansion of the right side of the chest. Herein may possibly lie one predisposing cause leading to a preferential use of the right side. But the evidence adduced fails to account for what, on such a theory, become abnormal deviations from the natural action of the body. The position of the liver, and the influence of a full inspiration, combine, according to Dr. Buchanan, to bring the centre of gravity of the body nearly over the right foot. Hence in actively overcoming a resistance from above, as when the carter bears up the shaft of his cart on his shoulder, the muscular action originates mainly with the lower limb of the same side, which partakes of the same muscular power and development as the corresponding upper

limb. On all such occasions, where the muscular action is brought directly into play in overcoming the weight or resistance, Dr. Buchanan affirms that the right shoulder is much more powerful than the left; but in the passive bearing of weights it is otherwise. The very fact that the centre of gravity lies on the right side, gives a mechanical advantage in the use of the left side in sustaining and carrying burdens; and this assigned preëminence of the left side and shoulder, as the bearer of burdens, is accordingly illustrated by means of an engraving, representing "a burden borne on the left shoulder as the summit of the mechanical axis passing along the right lower limb."

In the year following the publication of Dr. Buchanan's "Mechanical Theory," Dr. John Struthers communicated to the Edinburgh "Medical Journal," a paper, "On the relative weight of the viscera on the two sides of the body; and on the consequent position of the centre of gravity to the right side." In this he shows that the viscera situated on the right side of the medial line are on on average 22·75 oz. av. heavier than those on the left side. The right lung, in the male, weighs 24 oz., the left 21, giving a prepondance of 3 oz., in favour of the right. The average weight of the heart, in the male, is 11 oz. But the left side is not only the larger, but the thicker, and as the result of careful experiments by Dr. Struthers, he assigns to the right side a full third of the weight of the heart, or 3½ oz. for the right, and 7½ for the left side. Other viscera are estimated in like manner, with the result from the whole that the centre of gravity of the body, so far as it depends on their weight and position, is nearly three-tenths of an inch distant from the medial plane towards the right side. As a physical agent constantly in operation in the erect posture, Dr. Struthers states that this cannot but exert an influence on the attitudes and movements of the body and limbs; and he accordingly indicates his belief that this deviation of the centre of gravity furnishes the most probable solution of the causes "of the preference of the right hand by all nations of mankind."

The value of Dr. Struthers' determination of the exact weight and relative eccentricity of the viscera on the two sides of the body was fully recognised by Dr. Buchanan; and in a communication to the Philosophical Society of Glasgow in 1877, he stated that he had been led to greatly modify his earlier opinions. He had, as shown above, ascribed the predominance of the right hand over the left to the mechanical advantage which the right side has in consequence of the centre of gravity inclining to it. But he says, in his later treatise, "I judged hastily when I inferred that this is the ground of preference which prompts the great majority of mankind to use their right limbs rather than their left. The position of the centre of gravity on the right side is common to all men of normal conformation, and furnishes to all of them alike an adequate motive, when they are about to put forth their full strength in the performance of certain actions, to use the limbs of the right side in preference to those of the left. But such actions are of comparatively rare occurrence, and the theory fails to explain why the right limbs, and more especially the right hand, are preferred on so many occasions where no great muscular effort is required; and fails still more signally to explain why some men give a preference to the limbs of the left side, and others manifest no predilection for either." Dr. Buchanan accordingly proceeds to show, that there is not only the element of the position of the centre of gravity as the pivot on which all the mechanical relations of the two sides of the body turn; but there is, as he conceives, this other and no less important element. "The centre of gravity situated on the right side, is variously placed upwards or downwards, according to the

original make or framework of the body." In the great majority of cases this lies above the transverse axis of the body, with a consequent facility for balancing best, and turning most easily and securely, on the left foot, with the impulsive power effected by the muscles of the right lower limb. Man is thus, as a rule, right-footed: and, according to Dr. Buchanan, by a necessary consequence becomes right-handed. By a series of diagrams he accordingly shows the assumed variations: (1) the centre of gravity above the tranverse axis, with its accompanying right-handedness; (2) the centre of gravity corresponding with the transverse axis, which he assigns to the ambidextrous; and (3) the centre of gravity below the transverse axis begetting left-handedness. The whole phenomena are thus ascribed to the instinctive sense of equilibrium, which constitutes a nearly infallible guide in all the movements of the human body. The greater development of the organs of motion of the right side is therefore, as he conceives, not congenital, but arises solely from the greater use that is made of them. The relative position of the centre of gravity depends accordingly on the original conformation of the body. Broad shoulders, muscular arms, a large head and a long neck, all tend to elevate the centre point; while the contrary result follows from width at the haunches and a great development of the lower limbs.

The intermediate condition, in which the centre of gravity falls upon the transverse axis, with no instinctive tendency to call into action the muscles of the one side of the body in preference to those of the other, constitutes, according to Dr. Buchanan, the most happy conformation of the body. "It belongs," he says, "more especially to the female sex. It is this that so often renders a young girl a perfect model of grace and agility. It is the same conformation that enables the ballet-dancer to whirl round on her one foot till the spectators are giddy with looking at her, when she completes her triumph by revolving with the same ease and grace on her other foot also." He further adds: "If accurate statistics could be obtained, I believe it would be found that while a very great majority of males are right-handed, the proportion of females is less; and that, on the contrary, a larger proportion of females than of males are ambidextrous or left-handed."

Consistently with the ideas thus set forth, both Dr. Buchanan and Dr. Struthers regard right-handness as an acquired habit, though under the influence and control of the mechanical forces indicated by them. "As the question," says the latter, "in so far as it can bear on the cause of the preference of the right hand, must turn on the weight and position of the viscera in the child at the period when the predominance of the right hand is being gradually developed, in the second and third years and afterwards, it is necessary to make the calculation from the facts as presented in children." In a letter to myself he thus writes: "I have again and again verified the fact in my own children, that in early childhood there is no preference for one hand more than the other." But this, as has been already shown, may be partly due to modes of nursing and other temporary causes affecting the child in its first infantile stage; and though it may undoubtedly be affirmed of many, if not indeed of the majority, of children at that stage, a certain number will be found to manifest a distinct preference, at a very early age, for one or the other hand. In the case of a niece of my own, the left-handedness showed itself very soon; and in my grandson, it was independently observed by its mother and nurse, and brought under my notice, that so soon as he was able to grasp an object and transfer it from one hand to the other, he gave the preference to the left hand. A like decided preference for the right

hand, though doubtless also comparatively rare, is more frequent; and the further research is carried, the more manifest does it appear that—whatever be the originating cause,—the preferential use of what we designate the right hand is instinctive with a sufficiently large number to determine the prevalent usage; while with a smaller number an equally strong impulse is felt prompting to the use of the left hand, in defiance of all restraining influences. It is indeed always necessary to give full weight to the influences of education, the whole tendency of which, from early childhood, operates in one direction. The extent to which this is systematically employed to develop the use of the one hand at the expense of the other, is illustrated by the conventional rules for the use of the knife and fork. It is not sufficient that the knife shall be invariably held in the right hand. The child is taught to hold his knife in the right hand and his fork in the left when cutting his food; but when either the fork or spoon is used alone, it must forthwith be transferred to the right hand. All voluntary employment of the left hand in any independent action is discountenanced as awkwardness or gaucherie; and thus, with a large majority, especially among the more refined and artificial classes of society, it is rendered a comparatively useless member, employed at best merely to supplement the other. Yet I am not aware that left-handedness is greatly more prevalent among the rude and uncultured classes, or among savage than civilized races; as would certainly be the case if right-handedness mainly depended on an acquired habit. The Rev. George Brown, who has spent upwards of fourteen years as a missionary among the Polynesians, informs me that left-handedness is as rare among the natives of the Pacific islands as with ourselves; while in all their languages the distinction is clearly indicated. Dr. Rae, to whose own inveterate left-handedness I have alluded, thus writes to me in reference to its prevalence among the races of Arctic America: "Unfortunately, I did not take particular care to notice when among the Indians and Eskimos, whether any or many of them were left-handed. From what I have noticed, some of them seem to be ambidextrous. But from a curious story told me about a bear throwing a large piece of ice at the head of a walrus, and the narrator telling me that he threw it with the left forepaw, as if it was something unusual, probably left-handedness is not very common among the Eskimos."

Turning next to the idea set forth by Dr. Buchanan as to the greater preponderance of ambidexterity or left-handedness among females, the results of my own observation by no means tend to confirm this. I have already noted the case of a lady whose left-handedness is accompanied by great dexterity. I have repeatedly met with cases of ladies who use the needle skilfully with the left hand; but the results of enquiries addressed to musicians and music teachers, indicate that in the great majority of cases the cultivation of the left, as the weaker or less skilful hand, has to be sedulously enforced in the training of the female organist and pianist. It is because left-handed pianists are rare that their exceptional dexterity is noted, as in the case of a Canadian lady referred to above: "She had great advantages from her left-handedness. She was a very good performer on the piano, and her bass was magnificent."

Again as to the pirouetting of the trained ballet-dancer, I have been assured that much practise is required to obtain equal facility on either foot. Dr. Buchanan traces the development of the limbs in their active use, from the first effort of the child to stand erect; next, the learning to balance himself and turn round on a single foot, and so through a succession of stages, until at length "the child becomes right-footed. It is not till long

after that the right arm acquires its predominance." But the coördination of the right or left hand and the corresponding foot is by no means so invariable as to justify any such theory. Hopping, pirouetting, and standing on one foot, are comparatively exceptional actions. The two lower limbs are most frequently employed in necessarily alternate locomotion. The use of the lower limbs, moreover, is much more independent of direct conscious volition than that of the hands, and the purposes to which their action is applied are rarely of a nature to invite special attention to them. There is, however, an instinctive tendency with many, if not indeed with the majority, to use one foot in preference to the other, but not necessarily the corresponding one to the dextrous hand, be it right or left. In skating, for example, where military training has not habituated to the use of the left foot in starting, most persons have an instinctive preference for one foot. So also in football, it is not with most players a matter of mere chance which foot will be used in starting the ball. Possibly the same reason may help to account for the invariable tendency of a blindfold walker to deviate to one side or the other. It is scarcely possible to walk in a straight line with the eyes shut. The one leg apparently tends to outwalk the other. Guided mainly by my own experience, I remarked, when first writing on this subject, that "the same influences appear to affect the whole left side, as shown in hopping, skating, football," etc. But this is partial and uncertain. Dr. Brown-Sequard affirms that right-sidedness affects the arms much more than the legs, and in proof of this he states that "it is exceedingly rare that the leg is affected in the same degree by paralysis as the arm." Dr. Joseph Workman, for many years Medical Superintendent of the Provincial Lunatic Asylum at Toronto, thus writes to me: "When you say that left-footedness is (only) as frequent as left-handedness, I am quite sure you are in error. I remember well, when I was a boy, observing the fact among labouring men engaged in what was called in Ireland 'sodding' potatoes, in ridges about five feet wide, instead of planting in drills, that in any given number of men, from four up to a dozen, right and left-footedness prevailed about equally. Each pair carrying up the work of a ridge required to be right and left-footed men. I am myself left-footed; and of eight brothers, I believe about four were left and four right-footed. Sir Charles Bell, in asserting that 'no boy, unless he is left-handed, hops on the left foot,' asserts far more than the fact. I believe every boy will hop on his *spade foot;* at least I do so, and I am not left-handed; and I instinctively do so because I dig with this foot."

Dr. Buchanan states that "in all adults who use the right hand in preference to the left—that is, in the great majority of mankind,—the muscles of the right side, as well as the bones and other organs of motion, are more highly developed than those on the left side;" and the predominance of the upper limb follows, as a rule, the previous development of the lower limb on the same side. The power of overcoming weight or resistance, and that of passively bearing weights, he assigns to opposite sides,—both naturally resulting from the centre of gravity lying on the right side. If such be the case, the great majority of mankind should instinctively use the same side in bearing a burden. A favorable opportunity occurred for testing this question. During a voyage of some days in one of the large steamboats on the Mississippi River, my attention was attracted by the deck-porters, who at every landing are employed in transporting the freight to and from the levee, and in supplying the vessel with cordwood. They constitute, as a class, the rudest representatives of unskilled labour, including both whites and negroes. For hours

together they are to be seen going at a run to and from the lower deck of the vessel, carrying sacks of grain, bales, chests, or bundles of cordwood. Watching them closely, I observed that some gave the preference to the right and some to the left shoulder in bearing their burden ; and this whether, as with bale and sack, they had it placed on their shoulders by others, or, as with cordwood, they took the load up themselves. Noting in separate columns the use of the right and left shoulder, and in the case of loading with cordwood the employment of the right and left hand, I found the difference did not amount to much more than sixty per cent. In one case I noted 137 carry the burden on the left shoulder to 81 on the right ; in another case 76 to 45 ; and in the case of loading cordwood, where the natural action of the right hand is to place the burden on the left shoulder, so that the use of the right shoulder necessarily implies that of the left hand, the numbers were 65 using the left shoulder and 36 the right. Here, therefore, a practical test of a very simple yet reliable kind fails to confirm the idea of any such mechanical cause inherent in the constitution of the human frame, tending to a uniform exertion of the right side and the passive employment of the left, in muscular action.

While thus questioning some of the assumptions and deductions set forth by Dr. Buchanan, it must be acknowledged that his later theory has this great advantage over other attemps to account for right-handedness that it equally meets the cases of deviation from prevalent usage. No theory is worthy of serious consideration which deals with left-handedness as an exceptional deviation from habitual action : as where, in his earlier treatise, Dr. Buchanan expressed the belief that many instances of left-handedness are "merely cases of ambidextrousness, when the habit of using the left side, in whatever way begun, has given to the muscles of that side such a degree of development as enables them to compete with the muscles of the right side, in spite of the mechanical disadvantages under which they labour." "There is an awkwardness," he added, "in the muscular efforts of such men, which seems to indicate a struggle against nature." But for those indisputable cases of "men who unquestionably use their left limbs with all the facility and efficiency with which other men use their right," he felt compelled either to resort to the gratuitous assumption of "malformations and pathological lesions in early life, diseases of the right lung, contraction of the chest from pleurisy, enlargement of the spleen, distortions of the spine," etc. ; or to assume a complete reversal of the whole internal organic structure.

More recently, Dr. Humphry, of Cambridge, has discussed the cause of the preferential use of the right hand, in his monograph on "The Human Foot and Human Hand," but with no very definite results. Many attempts, he says, have been made to answer the question, Why is man usually right-handed ? "but it has never been done quite satisfactorily ; and I do not think that a clear and distinct explanation of the fact can be given. There is no anatomical reason for it with which we are acquainted. The only peculiarity that we can discern, is a slight difference in the disposition, within the chest, between the blood-vessels which supply the right and left arms. This, however, is quite insufficient to account for the disparity between the two limbs. Moreover, the same disposition is observed in left-handed persons and in some of the lower animals ; and in none of the latter is there that difference between the two limbs which is so general among men." Dr. Humphry accordingly inclines to the view that the superiority of the right hand is not natural, but acquired. "All men," he says, "are not right-handed ; some are left-

handed; some are ambidextrous; and in all persons, I believe, the left hand may be trained to as great expertness and strength as the right. It is so in those who have been deprived of their right hand in early life; and most persons can do certain things with the left hand better than with the right." So, far, therefore, Dr. Humphry's decision would appear to be wholly in favour of the conclusion that the superiority of the right hand is an acquired habit. But after stating thus much, he adds: "Though I think the superiority of the right hand is acquired, and is a result of its more frequent use, the tendency to use it in preference to the left is so universal, that it would seem to be natural. I am driven, therefore, to the rather nice distinction, that, though the superiority is acquired, the tendency to acquire the superiority is natural."

This "nice distinction" amounts to something very like an evasion of the real difficulty, unless we assume Dr. Humphry to mean only what Dr. Buchanan states, that during the weakness of infancy and childhood the two hands are used indiscriminately; and the preferential use of one side rather than the other does not manifest itself until the muscular system has acquired active development. All the processes by which dexterity in the manipulation and use of tools is manifested, are acquired, whether the right or the left hand be the one employed. Men are not born with carpentering, weaving, modelling and architectural instincts, requiring no apprenticeship or culture, like ants, bees, spiders, martins and beavers; though the aptitude in mastering such arts is greater in some than in others. If the tendency in their practice to use the right hand is natural, that is to say innate or congenital, then there need be no nice distinctions in affirming it. But on any clearly defined physiological deductions of right-handedness from the disposition of the organs of motion or circulation, or any other uniform relation of the internal organs and the great arteries of the upper limbs, left-handedness becomes mysterious, if not inexplicable, unless on the assumption of a corresponding reversal of organic structure; for Dr. Humphry's assertion that "in all persons the left hand may be trained to as great expertness and strength as the right," is contradicted by the experience of left-handed persons in their efforts to apply the same training to the right hand.

To the most superficial observer it is manifest that the anatomical disposition of the vital organs is not symmetrical. The heart lies obliquely, from above downwards, and from right to left; the trachea is on the right side, and the right and left subclavian veins and arteries are diversely arranged. There are also three lobes of the right lung, and only two of the left; and the liver is on the right side. Here, therefore, are sources of difference between the right and left sides of the body, which, if subject to variation, offer a possible explanation of the phenomenon that has so long baffled physiologists. To the variations in the disposition of those organs attention has accordingly been repeatedly directed; as in the occasional origin of the left subclavian artery before the right, which, as hereafter noted, Professor Hyrtl suggested as the cause of the transfer of dexterity to the left limb. But instances have repeatedly occurred of the entire transposition of the viscera. "There are men born," says Dr. Buchanan, "who may grow up and enjoy perfect health, in whom the position of all the thoracic and abdominal viscera is reversed. There are three lobes of the left lung and only two of the right, the liver is on the left side, and the heart is on the right; and so forth." Those, and other malformations, as well as pathological lesions, especially if they occur in early life, may affect the relative power of the two sides; and Dr. Buchanan, at a later date, reported a case that came under his own

notice, in which the entire transposition of the viscera coexisted with left-handedness. But he had already adopted the mechanical theory, subsequently modified, as explained above; and it is only in a closing remark in his paper of 1862 that he makes a passing reference to this remarkable coincidence.

Professor Hyrtl, of Vienna, the eminent anatomist already referred to, in discussing the cause of left-handedness in his "Handbuck der Topographischen Anatomie" (1860), affirms a correspondence between the ratio of left-handed persons and the occurrence of certain deviations from the normal arrangements of the blood-vessels. "It happens," he says, "in the proportion of about two in a hundred cases, that the left subclavian artery has its origin *before* the right, and in these cases left-handedness exists, as it also often actually does in the case of complete transposition of the internal organs; and it is found that the proportion of left-handed to right-handed persons is also about two to one hundred." Professor Hyrtl thinks that ordinarily the blood is sent into the right subclavian under a greater pressure than into the left, on account of the relative position of these vessels; that in consequence of the greater supply of blood, the muscles are better nourished and stronger; and that therefore the right extremity is more used. In cases of anomalous origin of the left subclavian, etc., the reverse occurs, and therefore the left hand is employed in preference. The theory of Professor Hyrtl has this feature to recommend it, that it assigns a cause for the prevalent habit, which, if confirmed, would equally account for the exceptional left-handedness; and no proffered solution of the question, founded on organic structure, is deserving of attention which fails to do so. But the statistics of such internal organic structure are not, like those of the transposition of the heart and immediately related organs, accessible in the living subject, unless in very rare exceptions; and the occurrence of one or two cases in which the deviation from the normal arrangement of the artery, or the entire transposition of the viscera, is found to coexist with left-handedness, may only be misleading.

A correspondent of "Nature" (June 9, 1870) refers to a case of transposition of the origin of the right subclavian artery, disclosed by the occurrence of aneurism, where the person was ascertained to have been undoubtedly right-handed. In the following year an interesting article by Dr. Pye-Smith appeared in the "Guy's Hospital Reports," and was subsequently reprinted, with additions, under the title of "The connection of left-handedness with transposition of viscera and other supposed anatomical causes." In this the author states that he found the deviation from the normal arrangement of the primary branches of the aorta, in which the right subclavian arises from the third part of the aortic arch, to occur four times in 296 dissections. As this variation, he says, "cannot be recognised during life, its connection with left-handedness is not easy to investigate. But in one case, at least, Dr. Peacock ascertained for me that the subject of this abnormality, whose heart and arteries he had examined for another purpose, was right-handed during life." Any one can tell on which side his heart lies; but the disposition of the subclavian artery is wholly beyond his cognizance; and, indeed, Professor Hyrtl, while referring to this abnormal organisation as one probable cause of left-handedness, does not affirm more than that the one has been ascertained in some cases to be an accompaniment of the other. The evidence that in other cases it has been unaccompanied by left-handedness shows that it is no necessary source of deviation from normal action.

The other theory, that left-handedness is an inevitable accompaniment of the trans-

position of the viscera, is more easily tested. It is one that has been repeatedly suggested; and has not only received the sanction of Professor Hyrtl, but is supported by some undoubted cases in which the two conditions coexisted. But, as Dr. Pye-Smith remarks, "a few such instances only prove that transposition of the viscera does not *prevent* the subject of the abnormality from being left-handed. Though attention has hitherto been little drawn to this point, there are enough cases already recorded to show that for a person with transposed viscera to be left-handed is a mere coincidence." In confirmation of this, Dr. Pye-Smith refers to four cases, one of which came under his own observation in Guy's Hospital, where the subjects of the abnormal disposition of the viscera had been right-handed. In the "Rochester (N.Y.) Express," of October, 1877, a notice appeared of an autopsy on the body of George Vail, of Whitby, Ontario, who had recently died in the Rochester Hospital. Dr. Stone, as there stated, "noticed upon the first examination, when the patient came for treatment, that there was what is technically called 'juxtaposition of the heart,' which is a very rare condition. He was gratified at the autopsy to have his diagnosis confirmed, the heart being found on the right side of the body, instead of the left." I immediately wrote to Whitby, and in reply was informed that no one had ever noticed in Vail any indication of his being left-handed. A similar case of the transposition of the viscera, in which, nevertheless, the person was right-handed, recorded by M. Géry, is quoted in Cruveillier's "Anatomie," (I. 65.) Another is given by M. Gachet, in the "Gazette des Hospitaux," August 31, 1861; and a third in the Pathological Transactions, Vol. XIX. p. 447 ("Nature," April 28, 1870). This evidence suffices to prove that there is no true relation between the transposition of the viscera and left-handedness. Dr. Struthers has shown that "as far as the viscera alone are concerned, the right side is at least 22¾ ounces heavier than the left, and that this is reduced 7¾ ounces by the influence of the contents of the stomach, leaving a clear preponderance of at least 15 ounces in favour of the right side." The preponderance of the right side, he adds, is probably considerably greater than 15 ounces, and it is rendered still more so in the erect posture. The total weight of viscera on the right side he states at 50¾ ounces, while that of the left side is only 28 ounces, giving a visceral preponderance on the right side of 22¾ ounces. But if this relative excess of weight on the right side be the true source of right-handedness, the transposition of the viscera ought to be invariably accompanied with a corresponding change. A single example of the preponderant cause, unaccompanied by the assumed effect, is sufficient to discredit the theory.

There remains to be considered the source suggested by Professor Gratiolet, when he turned from the organs in immediate contact with the arm and hand to the cerebral centre of nerve force. The statements advanced by him that the anterior convolutions of the left side of the brain are earlier developed than those of the right, when taken in connection with the well-known decussation of the nerve-roots, would account for the earlier development of the muscles and nerves of the right arm; but his opinion has been controverted by competent observers. This, however, does not dispose of the question. A recent observer definitely affirms that "the large proportion of cases of ataxic aphasia occur in association with right-sided hemiphlegia, although others are on record in which it has appeared in connection with left-sided hemiphlegia in left-handed persons." (Encyc. Britann, art. *Aphasia.*) In those an intimate relation is thus established between right or left-handedness and the development of the opposite cerebral hemisphere. "The

opinion," says Dr. Pye-Smith, "that some difference between the two sides of the brain has to do with our preference for the right hand over the left may, perhaps, be supported by two very interesting cases of aphasia occurring in left-handed persons, recorded by Dr. Hughlings Jackson and Dr. John Ogle. In both these patients there was paralysis of the *left* side; so that it seems likely that in these two left-handed people the right half of the brain had the functions, if not the structure, which ordinarily belong to the left. To these cases may be added a very remarkable one published by Dr. Wadham (St. George's Hosp. Rep. 1869). An ambidextrous, or partially left-handed lad, was attacked with left hemiplegia and loss of speech; he had partly recovered at the time of his death, twelve months later, and then the right insula, and adjacent parts, were found softened."

The remarkable difference in the convolutions of different brains, and the consequent extent of superficies of some brains over others apparently of the same size, have been a matter of special observation, with results lending confirmation to the idea that great development of the convolutions of the brain is the concomitant of a corresponding manifestation of intellectual activity. But the complexity in the arrangement of these convolutions, and the consequent extent of superficies, often differ considerably in the two hemispheres of the same brain; and it seems not improbable that left-handedness may prove to be traceable to certain structural differences between the right and left hemispheres. The variations in shape and arrangement of the convolutions in either hemisphere may be no more than the accidental folds of the cerebral mass, in its later development in the chamber of the skull; and within ordinary limits they probably exercise no appreciable influence on physical or mental activity. From long and careful observation, especially of children, I am satisfied that with the great majority, right-handedness is mainly the result of education, or a compliance with prevailing usage. Little effort would be needed with such to superinduce left-handedness. But there is a sufficient number of persons naturally and instinctively right-handed to determine the bias of the majority; though they cannot influence another, and smaller number, who have an equally strong and ineradicable impulse to the use of the left hand. Where, therefore, opportunity is afforded for examination of the brain, it is desirable that in every case of marked inequality between the two hemispheres, inquiry should be instituted as to the concurrence of a strongly pronounced right or left-handedness.

But it has also been affirmed as the result of repeated observations, that there is often a decided difference in the weight of the two hemispheres of the brain. M. Broca stated that in forty brains he found the left frontal lobe heavier than the right; and Dr. Boyd, when describing the results obtained by him from observations on upwards of 500 brains of patients in the St. Marylebone Hospital, says: "It is a singular fact, confirmed by the examination of nearly 200 cases at St. Marylebone, in which the hemispheres were weighed separately, that almost invariably the weight of the left exceeded that of the right by at least the eighth of an ounce." Dr. Brown-Sequard also, as hereafter noted, makes this apparent excess in weight of the left hemisphere of the brain the basis of very comprehensive deductions. Again Dr. Bastian affirms, as the result of careful observation, that the specific gravity of the grey matter from the frontal, parietal, and occipital convolutions, respectively, is often slighly higher on the left than it is on the right hemisphere. Such deductions, however, have been questioned; and Professor Wagner and Dr. Thurnam both state that their careful independent investigations failed to

confirm the results arrived at by M. Broca and Dr. Boyd. From the weighing of the two hemispheres of eighteen distinct brains, Professor Wagner found the right hemisphere the heavier in ten, and the left in six cases, while in the remaining two they were of equal weight. Dr. Thurnam, without entering into details, states that the results of his weighings did not confirm Dr. Boyd's observations ; adding that "fresh careful observations are certainly needed before we can admit the general preponderance of the left hemisphere over the right." Though the two hemispheres of the brain are sufficiently distinct, they are united at the base ; and even with the most careful experimenters, the section through the cerebral peduncles and the corpus callosum is so delicate an operation that a very slight bias of the operator's hand may affect the results. That a difference however is occasionally demonstrable in the weight of the two hemispheres is unquestionable, and encourages further observation with a view to ascertain definitely how far the evidence is in accordance with the hypothesis of left-handedness being referable to an exceptionally greater action of the right side of the brain. It is in full accordance with what has already been affirmed as to the very partial prevalence of any strongly defined bias in the majority for the preferential use of either hand, that many brains should come under the notice of careful observers where little or no difference can be found between the two hemispheres. But weight is not the only element of variation. Dr. Bastian, in "The Brain as an Organ of Mind," draws attention to the unsymmetrical development of the two hemispheres as one of the most notable peculiarities of the human cerebrum. This is not only the case with reference to the number and arrangement of the convolutions, but it has been noted by various anatomists that the left hemisphere is very frequently slightly longer than its fellow. Nor are the distinct functions and the independent action of the two hemispheres of the brain by any means limited to the range of action now under review.

Among the higher cerebral functions, the power of articulate speech has been assigned to the left hemisphere ; and Dr. Broca located it specifically in the third left convolution. Commenting on this, Dr. Bastian remarks: "It has been thought that a certain more forward condition of development of the left hemisphere—as a result of hereditary right-handedness recurring through generation after generation,—might gradually become sufficient to cause the left hemisphere to take the lead in the production of speech-movements. Some little evidence exists, though at present it is very small, to show that it is left-handed people more especially who may become aphasic by a lesion of the right third frontal gyrus." Dr. Bastian further assumes it to be indisputable that the greater preponderance of right-hand movements in ordinary individuals must tend to produce a more complex organization of the left than of the right hemisphere ; and this both in its sensory and motor regions. With the left-handed, however, so many motives are constantly at work tending to call the right hand into play, that the compensating influences must in their case tend to check any inequality in the development of the two hemispheres. As to the supposed greater liability of left-handed people to aphasia, I have failed to find any confirmation of this idea. But here it will be seen that, while Dr. Bastian recognises a correlation between the development of one or other cerebral hemisphere and the greater dexterity of the opposite hand, he is inclined to regard right or left-handedness as the cause, rather than the effect.

Dr. Brown-Sequard, who strongly favours the idea of superiority, both in size and

weight, of the left over the right cerebral hemisphere, also ascribes the source of this to the greater frequency and energy of all right-hand movements. He reverts to an argument derived from left-handedness when discussing his theory that the two hemispheres practically constitute two distinct brains, each sufficient in itself for the full performance of nearly all mental operations, though each has also its own special functions, among which is the control over the movements and the organs of opposite sides of the body. "Every organ," he says, "which is put in use for a certain function gets developed, and more apt or ready to perform that function. Indeed, the brain shows this in point of mere size; for the left side of the brain, which is used most, is larger than the right side. The left side of the brain also receives a great deal more blood than the right side, because its action preponderates; and every organ that acts much receives more blood." He accordingly affirms that the growth of the brain up to forty years of age, if not indeed to a considerably later period of life, is sufficiently marked to require the continued enlargement of the hat. Speaking of himself, as having then passed his fifty-sixth year, he says:—"There is no period of six months that has passed that I have not found my hat, if neglected and put aside, has become too small. The head growing is very strong proof that the brain grows also." The opinions advocated by the leading anatomists of Europe in the earlier years of the present century, differed widely from this. It was indeed maintained by Sœmmering, the Wenzels, and Tiedemann, that the brain attained its greatest development not later than at seven or eight years of age. But, without going so far as Dr. Brown-Sequard is prepared to do, the old idea as to the complete development of the brain in youth is now abandoned, and the latest observers have produced evidence in proof of the brain increasing in weight, so that the greatest average weight occurs between thirty and forty years of age. They do not, however, indicate any such increase in actual bulk as Dr. Brown-Sequard implies. In the majority of cases, indeed, the comparatively early ossification of the sutures would alone suffice to preclude the possibility of such a growth of the head, as Dr. Brown-Sequard assumes to be demonstrable even beyond the age of fifty-six. Without due allowance for the stiffness of a new hat, and the shrinking of an old one when out of use, hat-measurements may prove very deceptive. On his assumption relative to the normal excess of the left hemisphere of the brain, there ought to be a greater equality between the two hemispheres in a left-handed than a right-handed person, owing to the more equal employment of the two sides of the brain by the latter. But he fails to appreciate the bearings of his own argument in the case of a left-handed person conforming in many ways to the usage of the majority, yet instinctively giving the preference to the left hand. He dwells on the fact that very few left-handed persons have learned to write with the left hand, and that those who can do not write nearly so well with it as with the right hand. Even in persons who are left-handed naturally, so that the right side of the brain may be assumed to control the reasoning faculties and their expression, he argues that the left side of the brain "can be so educated that the right hand, which that side of the brain controls, produces a better handwriting than that by the left hand, though that is controlled by the better developed brain." But the reasoning is alike partial and misleading. The left-handed person systematically submits to disabilities in his efforts to comply with the usage of the majority, not only in holding his pen in the right hand, but in the direction and slope of the writing. A left-handed race would naturally write from right

to left, sloping the letters towards the left, and so would place the right-handed penman at a like disadvantage, wholly independent of any supposed change in the functions or preponderating energy of either hemisphere of the brain. But even in the absence of practice, the command of the left hand in the case of a truly left-handed person is so great that very slight effort is required to enable him to write with ease with that hand.

In so far as right-handedness is a result of organic structure, and not a mere acquired habit; some trace of it should be found in the lower animals; though in a less degree. Dr. Buchanan, in discussing his "Mechanical Theory," notes that, "While the viscera of the quadruped have the same general lateralised position as in man, there is a reason why this should be carried to a greater extent in man than in the quadruped, owing to the much greater lateral development of the chest and abdomen of the human figure, in order to adapt it to the erect posture, as contrasted with the great lateral flattening of the trunk in quadrupeds. The equipoise is therefore more disturbed in man than in the quadruped." In the case of the monkey, its necessities as a climber no doubt tend to bring all its limbs into constant use; but, possibly, careful study of the habits and gestures of monkeys may disclose, along with their ambidextrous skill, some traces of a preference for the limbs on the one side. The elephant has been repeatedly affirmed to betray a strongly marked right-sidedness; and this is reiterated in a communication by Mr. James Shaw to the Anthropological section of the British Association, where he notes the "curious fact that elephants have been frequently known to use the right tusk more than the left in digging up roots, and in doing other things." But the statement is vague, and, even if confirmed by adequate proof, can scarcely be regarded as the equivalent of right-handedness. In dogs it may be noticed that they rarely move in the direct line of their own body, but incline to one side or the other, the right hind-foot stepping into the print of the left fore-foot, or *vice versa*. In the horse, as in other quadrupeds, a regular alternation in the pace is manifest, except when modified by education for the requirements of man. I experienced no difficulty in teaching a favourite dog to give the right paw; and no child could more strongly manifest a sense of shame, than he did when reproved for the gaucherie of offering the wrong one. The saddle horse is trained to prefer the right foot to lead with in the canter; while the same animal is educated differently when destined for a lady's use; but I have been informed by two experienced veterinary surgeons that, while some horses learn with very slight training to start with the right foot, others require long and persevering insistency before they acquire the habit. A curious relation between man and the lower animals in the manifestation of the organic influences here noted, is indicated by a writer in the "Cornhill Magazine," when referring to the well ascertained fact that aphasia is ordinarily accompanied with disease of the right side of the brain, says: "Right-sidedness extends to the lower races. Birds, and especially parrots, show right-sidedness. Dr. W. Ogle has found that few parrots perch on the left leg. Now, parrots have that part at least of the faculty of speech which depends on the memory of successive sounds, and of the method of reproducing such imitation of them as a parrot's powers permit; and it is remarkable that their left brain receives more blood, and is better developed than the right brain." The same writer expresses his doubt as to monkeys showing any tendency to right-handedness; but with the constant use and training of the hands by the quadrumana in their arboreal life, opportunities for the manifestation of any

instinctive preference for either hand must be rare; and is likely to elude all but the most watchful observers.

A paper was communicated by Dr. Delaunay to the Anthropological Society of France, on the subject of right-handedness. I only know of it by an imperfect notice, in which he is reported to look on the preferential use of the right hand as a differentiation arising from natural selection, while he regards ambidexterity as a mere "survival." But Dr. Pye-Smith long ago remarked that "it is clear that in the progress of civilisation one or other hand would come to be selected for the more characteristic human actions for which only one is necessary, such as wielding a pen or other weapon;" but he recognises the insufficiency of the suggestion, and adds in a foot note: "The difficult point is to guess by what process the right rather than the left hand has been so universally preferred." He then glances at possible guidance to be derived from the study of the habits of savage tribes; though still the old difficulty recurs; and he thus proceeds; "In default of any better suggestion, might one suggest an hypothesis of the origin of right-handedness from modes of fighting, more by way of illustration than as at all adequate in itself? If a hundred of our ambidextrous ancestors made the step in civilisation of inventing a shield, we may suppose that half would carry it on the right arm and fight with the left, the other half on the left and fight with the right. The latter would certainly, in the long run, escape mortal wounds better than the former, and thus a race of men who fought with the right hand would gradually be developed by a process of natural selection." To this idea of right-handedness as one of the results of a survival of the fittest, Dr. Delaunay adds the statement, professedly based on facts which he has accumulated, that ambidexterity is common among idiots. The results noted probably amount to no more than the negative condition of general imbecility, in which the so-called ambidexterity of the idiot involves, not an exceptional skill in the left hand equalising it with the right, but only a succession of feeble and often aimless actions manifesting an equal lack of dexterity in either hand. Where left-handedness is strongly developed, it is, on the contrary, not only accompanied with more than average dexterity in the organ thus specialised; but also with a command of the use of the right hand, acquired by education, which gives the individual an advantage over the great majority of right-handed men. The surprise occasionally manifested at any display of dexterity by left-handed performers, as though it were accomplished under unusual disadvantages, is altogether unjustified. In reality, a strongly developed left-handedness is, equally with a strongly developed right-handedness, an indication of exceptional dexterity. Such skill as that of the left-handed slingers of the tribe of Benjamin is in no way exceptional. All truly left-handed, as well as all truly right-handed persons, are more likely to be *dextrous* than those who are unconscious of any strong impulse to the use of either hand. The bias, whether to the right or the left, is, I feel assured, the result of special organic aptitude. With the majority no well-defined bias betrays any unwonted power, and they merely follow in this, as in so much else, the practice of the greater number. But there is no such difference between the two hands as to justify the extent to which, with the great majority, one is allowed to become a passive and nearly useless member. The left hand ought to be educated from the first no less than the right, instead of leaving its training to be effected, imperfectly and with great effort, in later life, to meet some felt necessity. Wherever the early and persistent cultivation of the full use of both hands has been accomplished, the result is greater

efficiency without any counteracting awkwardness or defect. In certain arts and professions, both hands are necessarily called into play. The skilful surgeon finds an enormous advantage in being able to transfer his instrument from one hand to the other. The dentist has to multiply instruments to make up for the lack of such acquired power. The fencer who can transfer his weapon to the left hand, places his adversary at a disadvantage. The lumberer finds it indispensable in the operations of his woodcraft to learn to chop timber right and left-handed; and the carpenter may be frequently seen using the saw and hammer in either hand, and thereby not only resting his arm, but greatly facilitating his work. In all the fine arts the mastery of both hands is advantageous. The sculptor, the carver, the draftsman, the engraver, and cameo-cutter, each has recourse at times to the left hand for special manipulative dexterity; the pianist depends little less on the left hand than the right; and as for the organist, with the numerous pedals and stops of the modern grand organ, a quadrumanous musician would still find reason to envy the ampler scope which a Briareus could command. On the other hand, it is no less true that, while the experience of every thoroughly left-handed person shows the possibility of training both hands to a capacity for responding to the mind with promptness and skill, at the same time it is none the less apparent that in cases of true left-handedness there is an organic specialization which no enforced habit can wholly supersede.

The conclusion at which I finally arrive is that left-handedness is due to an exceptional development of the right hemisphere of the brain. I have long delayed the printing of this monograph on the subject, in expectation of some response to appeals I have repeatedly made to medical friends, in the hope that the occurrence of some strongly marked case of left-handedness among hospital or other patients might afford an opportunity of bringing it to the test. But in the passive condition of mortal disease there is little occasion to draw attention to the left-handed action of a patient; and I must leave the point to be determined hereafter under some favouring opportunity. My own brain has now been in use for more than the full allotted term of three score years and ten, and the time cannot be far distant when I shall be done with it. When that time comes, I should be glad if it were turned to account for the little further service of settling this physiological puzzle. If my ideas are correct, I anticipate as the result of its examination, that the right hemisphere will not only be found to be heavier than the left, but that it will probably be marked by a noticable difference in the number and arrangements of the convolutions.

NOTE.—The subject which is fully dealt with in the above paper has been previously considered by the writer in some of the aspects here reviewed. He has now embodied these, along with the results of more recent investigations. See "Right-handedness," Canadian Journal, N.S., 1871, Vol. xiii. p. 193; "Left-handedness," *Ibid.*, 1872, Vol. xiv. p. 465; "Primæval Dexterity," Proceedings of the Canadian Institute, 1885, Vol. iii. p. 125; "Palæolithic Dexterity," Transactions of the Royal Society of Canada, 1886, Vol. iii. Sec. ii. p. 119.

II.—*Local Government in Canada: an Historical Study.*

By JOHN GEORGE BOURINOT.

(Presented May 27, 1886.)

"Local assemblies of citizens constitute the strength of free nations. Municipal institutions are to liberty what primary schools are to science; they bring it within the people's reach; they teach men how to use and how to enjoy it. A nation may establish a system of free government, but without the spirit of municipal institutions, it cannot have the spirit of liberty." DE TOCQUEVILLE, *Democracy in America* Vol. I. Ch. v.

I.—INTRODUCTORY.

I propose to give in this paper an historical review of the origin and growth of the municipal system of Canada. Such a review suggested itself to me after a careful perusal of the valuable series of essays that are appearing from the press of the Johns Hopkins University in the state of Maryland.[1] These studies are remarkable for the information they give on a subject to which historians of the United States have hitherto devoted very little attention. The papers that have already been published with respect to the local institutions of Virginia, of Maryland, and of the New England States, enable us to follow step by step the progress of the people in self-government. Under the conviction that a similar paper on local government in Canada may be of some value to students of political science in the absence of any work or treatise hitherto devoted to the subject, I shall endeavour to evolve out of a chaos of old documents, statutes, and histories such facts as may give a tolerably accurate idea of the gradual development of those local institutions on which must always rest, in a great measure, the whole fabric of popular liberty.

Such a subject ought to be interesting to every Canadian, but especially to the historical student. The former may care to learn something of the history of those institutions which perform so important a part in the economy of his daily life. The latter must find a deeper attraction in tracing the origin of the municipal government of this country even to those ancient institutions, which, very many centuries ago, kept alive a spirit of liberty among our English forefathers and among the German nations.[2]

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[1] Johns Hopkins University Studies in Historical and Political Science, Herbert B. Adams, editor. Three series have already appeared.

[2] "The origin of local government in England, like that of our civil liberty, must be sought in the primitive but well ordered communities of our Saxon forefathers. . . . . The German nations, as described by Cæsar and Tacitus, were nothing but associations of self-governed villages, or larger districts, occupied by separate families, or clans, among whom there was not even the shadow of a common national allegiance, except for the purpose of war. Such was the organization of the Saxons, Jutes and Angles, when they first settled in England." Cobden Club Essays, 1875, Local Government in England, by Hon. G. C. Brodrick, p. 3.

The Dominion of Canada now extends over a territory between the Atlantic and Pacific oceans, even greater in area than that of the United States. Its organized divisions consist of the provinces of Prince Edward Island, Nova Scotia, New Brunswick, Quebec, Ontario, Manitoba, and British Columbia, each of which possesses a very liberal system of representative government. Every province has a lieutenant-governor, appointed by the government of the Dominion, and a legislature composed in Nova Scotia, New Brunswick and Quebec, of a legislative council nominated by the crown, and of a legislative assembly elected by the people on a very liberal franchise. In Manitoba, British Columbia, and Ontario, there is no second chamber, while, in Prince Edward Island, that body is elected by the people. The Northwest Territories which extend from Manitoba to the frontier of British Columbia—territories out of which may be formed many states as large and fertile as Minnesota—are as yet divided into mere territorial districts, over which preside a lieutenant-governor, appointed by the Ottawa government, and a council, partly nominated by the crown, and partly elected by the people. In all of the provinces, as well as in the principal settlements, villages and towns of the Northwest, now exists a system of municipal institutions which are the growth of the experience of the past forty years, since the people of the old provinces of Canada have grown in population and wealth, and have fully recognized the necessity of managing their purely municipal and local affairs in councils elected by themselves. These municipal institutions are the creation, and are under the jurisdiction, of the provincial legislatures, in accordance with the constitution, known as the British North America Act 1867, which gives the control of all general national affairs to the federal government, and the administration of all local matters to the legislatures of the provinces. As the municipal institutions of Canada, in the first instance, owe their existence to statutory enactments of the legislatures of the provinces, so they can be amended only by the authority of the same superior bodies.

The political history of Canada may be divided into three important epochs. First of all, there was the era of the French Regime which lasted for about a century and a half, from the 3rd of July, 1608, when Champlain established his seat of government on the picturesque heights of Quebec, until 1760, when France gave up the contest with England, for the supremacy on the continent of America. Then came the period from 1760 to 1840, when the provinces slowly increased in population under British Rule, and gained valuable experience in the working of representative institutions. Then followed the important and interesting period from 1840 to 1867, when the political liberties of the people were enlarged, and they were given responsible government in the full sense of the term. Since 1867, the various provinces, united as the Dominion of Canada, have entered on a fourth era pregnant with promise.

II.—The French Regime, 1608–1760.

During the days of French domination in Canada, we look in vain for evidences of self-government in any form, such as we see in the town-meetings of Massachusetts and in the counties and parishes of Virginia, or in other local divisions of the old English Colonies in America, in all of which we can see the germs of liberty and free institutions

from the earliest days of their history. The system of government that was established on the banks of the St. Lawrence was the very opposite of that to which the people of New England always clung as their most valued heritage. While the townsfolk of Massachusetts were discussing affairs in town-meetings, the French inhabitants of Canada were never allowed to take part in public assemblies, but were taught to depend in the most trivial matters on a paternal government. Canada was governed as far as possible like a province of France. In the early days of the colony, when it was under the rule of mere trading companies chartered by the king, the governors practically exercised arbitrary power, with the assistance of a council chosen by themselves. Eventually, however, the King, by the advice of the great Colbert, took the government of the colony into his own hands, and appointed a governor, an intendant, and a supreme or sovereign council to administer under his own direction the affairs of the country. The governor, who was generally a soldier, was nominally at the head of affairs, and had the direction of the defences of the colony; but to all intents and purposes, the intendant, who was a man of legal attainments, had the greatest influence in many ways. He had the power of issuing ordinances which had the effect of law, and in the words of his commission "to order everything as he shall see just and proper." An examination of these ordinances proves conclusively the arbitrary and despotic nature of the government to which the people were subject, and the care that was taken by the authorities to give them as little liberty as possible in the management of those local matters over which the inhabitants of the British Colonies exercised the fullest control. These ordinances regulated inns and markets, the building and repairs of churches and presbyteries, the construction of bridges, the maintenance of roads, and all those matters which could affect the comfort, the convenience, and the security of the community.

It is interesting to notice how every effort that was made during the continuance of the French rule, to assemble the people for public purposes, and give them an opportunity of taking an interest in public questions, was systematically crushed by the orders of the government in accordance with the autocratic spirit of French monarchy. The first meeting of the inhabitants was called on the 18th of August, 1621, by Champlain, in Quebec, for the purpose of getting up a petition to the king on the affairs of Canada.[1] But this was a very exceptional event in the history of the colony. A public meeting of the parishioners to consider the cost of a new church could not be held without the special permission of the intendant. It was the custom in the early days of the colony to hold public meetings in Quebec under the chairmanship of members of the sovereign council for the purpose of discussing the price and quality of bread and the supply of firewood, "Such assemblies, so controlled," says Parkman, "could scarcely, one would think, wound the tenderest susceptibilities of authority; yet there was an evident distrust of them, and after a few years this modest shred of self-government is seen no more."[2]

We have a striking illustration of the arbitrary policy pursued towards the colony by the king and his ministers in the action they took with reference to an attempt made by Count de Frontenac in 1672 to assemble the different orders of the colony, the clergy, the *noblesse* or *seigneurs*, the judiciary, and the third estate, in imitation of the old institutions

[1] Doutre et Lareau, Histoire Genérale du Droit Canadien, i. 13, 14.

[2] Parkman's Old Régime in Canada, pp. 280, 281.

of France. He compelled the estates of Canada, as he called them, to take the new oath of allegiance before a great assemblage of persons. The French king did not long leave the haughty governor in doubt as to his opinion of this innovation on the policy laid down for the government of the colony. "The assembling and division that you have made," wrote Colbert, "of all the inhabitants of the country into three orders or estates with the object of administering to them the oath of allegiance might have some effect for the moment; but it is well to consider that you should always observe in the administration of public affairs those forms which are followed here, and that our kings have deemed it inexpedient for a long time past to assemble the states-general of their kingdom, with the view perhaps of insensibly destroying the ancient system. Under these circumstances you should very rarely, and in fact it would be better if you should never give this form to the people of the country. It will be advisable, even after a while, when the colony is more vigorous than at present, to suppress by degrees the syndic who presents petitions in the name of the inhabitants, as it seems better that everyone should speak for himself, and no one for all."[1]

The history of the officer just named, the syndic, of itself gives us some striking evidence of the stern determination of the government to stamp out every vestige of popular institutions, however insignificant it might be. The *syndics d'habitations* are said to have been originally constituted by Colbert to act as municipal officers appointed by the people of the cities to preserve public rights. The references to these functionaries in the history of those times are very vague: they appear to have existed in Quebec, Montreal, and Three Rivers in 1647, but they ceased to exist by 1661. The government was determined to have no town-meetings or municipal officers in the province of Quebec. In 1663, a meeting of the citizens of Quebec was called by the supreme council, on the requisition of the attorney-general, to elect a mayor and two aldermen for that town. The people accordingly chose Jean-Baptiste Legardeur, Sieur de Repentigny, for mayor, and Jean Madry and Claude Charron for aldermen; but these persons soon resigned in consequence, it is well understood, of the influence brought to bear upon them by the authorities. They declared that, having regard to the smallness of the population, it would be better to appoint a syndic. The first election held for this purpose was annulled, and another, called irregularly by the governor, made a nomination. It appears that the bishop, Monseigneur de Laval, a haughty, determined man, who proved himself during his memorable career in Canada a true descendant of the great house of Montmorency, was opposed to the action taken in this matter, and his friends in the council protested against the swearing in and installation of the syndic. The governor, M. de Mezy, took upon himself to suspend the obstinate councillors, and consequently committed a violation of the royal instructions, for he had no power of appointing these functionaries without the consent of the bishop, or of dismissing or suspending them at his own discretion.[2] Without dwelling further on these official squabbles, frequent enough in those times, it is only necessary to add that the sequel was that the country heard no more of attempts to establish even a semblance of popular representative government in the towns of Canada. The policy of the king and his advisers was determinately antago-

[1] Doutre et Lareau, pp. 169, 170; Chauveau, Notice sur la publication des Régistres du Conseil Souverain, etc., p. 34.

[2] Chauveau, pp. 24-30; Garneau, i. 179, 180; Parkman's Old Régime, p. 281; Doutre et Lareau, p. 129.

nistic to such institutions. "It is of great consequence," wrote Meules to the minister in 1685, "not to give any liberty to the people to express their opinions."[1]

The administration of local affairs was exclusively under the control of the king's officers at Quebec. As I have already shown, the ordinances of the intendant and of the council were the law. The local or territorial divisions of the colony had no connection, as the townships, parishes, and counties of the English colonies in America, with the local affairs of the people. The country was subdivided into the following divisions for purposes of government, settlement and justice:[2]—

1. Districts.
2. Seigniories.
3. Parishes.

The Districts were simply established for judicial and legal purposes, and each of them bore the name of the principal town within its limits; viz., Quebec, also called the *Prévôté de Québec*, Montreal, and Three Rivers. In each of these districts there was a judge, appointed by the king, to adjudicate on all civil and criminal matters. An appeal was allowed in the most trivial cases to the supreme or superior council, which also exercised original jurisdiction.[3]

The greater part of Canada was divided into large estates or seigniories, which were held under a modified system of feudal tenure, established by Richelieu in 1627,[4] with the view of creating a colonial aristocracy or *noblesse*, and of stimulating settlement in a wilderness. By this system, which lasted until 1854,[5] lands were as a rule held immediately from the king *en fief* or *en roture*. The seignior, on his accession to the estate, was required to pay homage to the king, or to his feudal superior in case the lands were granted by another than the king.[6] The seignior received his land gratuitously from the crown, and granted them to his vassals who were generally known as *habitants* or cultivators of the soil. The *habitant* or *censitaire* held his property by the tenure of *en censive*, on condition of making annual payments in money or produce known as *cens et rente*, which were ridiculously small in the early times of the colony.[7] He was obliged to grind his corn at the seignior's mill (*moulin banal*[8]), bake his bread in the seignior's oven, give his lord a tithe of the fish caught in his waters, and comply with other conditions at no time onerous or strictly enforced in the days of the French regime. The land of the *censitaire* went to his heirs, but in case he sold it during his life time, one twelfth of the purchase-money was given under the name of *lods et ventes* to the seignior. In case the latter at any time transferred, by sale or otherwise, his seigniory—except of

[1] Meules au Ministre, 1685.

[2] Bouchette, A Topographical Description of the Province of Lower Canada, etc., pp. 86, 87.

[3] Doutre et Lareau, p. 130.

[4] Garneau, i. 171.

[5] It was abolished after many years of agitation by 18 Vict. c. 3.

[6] Parkman, p. 245.

[7] Half a *sou*, and half a pint of wheat, or a few live capons, wheat and eggs, would represent the *cens et rente* for each arpent in early days. Parkman's Old Régime, p. 249.

[8] The government appear to have rigidly enforced the seignior's rights in the case of the *moulin banal*. For instance, in 1706, the intendant issued an ordinance forbidding the Dame de La Forêt from turning her mill in the county of St. Laurent while there was a *moulin banal* in that place. Doutre et Lareau, p. 237.

course in the event of natural hereditary succession—he had to pay a *quint* or fifth part of the whole purchase money to his feudal superior, but he was allowed a reduction (*rabat*) of two thirds when the money was paid down immediately.[1]

The system, irreconcilable as it is with our modern ideas of free settlement, had some advantages in a new country like Canada, where the government managed everything and colonization was not left to chance. The seignior was obliged to cultivate his estate at the risk of forfeiture—and many estates were from time to time resumed by the crown—and consequently it was absolutely necessary that he should exert himself to bring settlers upon his lands. The conditions of the tenure were in early times so trivial as not to burden the settler. The obligation of the *censitaire* to grind his corn in the seignior's mill was an advantage, since it insured him the means of procuring bread which it would have been otherwise difficult to find in a country where there was neither money nor enterprise. The seigniories were practically so many territorial divisions where the *seigneur* was master and adviser to his *censitaires*. He had the right of dispensing justice in certain cases, though this was a right he very rarely exercised.[2] As respects civil affairs, however, both lord and vassal were to all intents and purposes on the same footing, for they were equally ignored in matters of government.

In the days of the French regime, the only towns for many years were Quebec, Montreal and Three Rivers. Villages were but slow in growth, despite the efforts of the government to encourage them. In remote and exposed places—like those on the Richelieu, where officers and soldiers of the Carignan regiment had been induced to settle—palisaded villages had been built; but in the rural parts of the province generally, the people appear to have considered their own convenience. The principal settlements were, in the course of time, established on the banks of the St. Lawrence from Quebec to Montreal. The people chose the banks of the river, as affording them in those days the easiest means of intercommunication. As the lots of a grant *en censive* were limited in area—four arpents in front by forty in depth—the farms in the course of time assumed the appearance of a continuous settlement on the river. These various settlements became known in local phraseology as *Côtes*, apparently from their natural situation on the banks of the river. This is the derivation of Côte des Neiges, Côte St. Louis, Côte St. Paul, and of many picturesque villages in the neighborhood of Montreal and Quebec.[3]

The parishes were established for ecclesiastical purposes, and were grouped on each side of the St. Lawrence and Richelieu. Their extent was exactly defined in September, 1721, by a regulation made by Messieurs de Vaudreuil and Begon, assisted by the Bishop of Quebec, and confirmed by an *Arrêt du Conseil* of the 2nd of March, 1722.[4] These parishes are constantly referred to in the ordinances of the superior council, in connection with the administration of local affairs. In the parishes, the influential men were the *Curé*, the seignior, and the captain of the militia.[5] The seignior, from his social position,

[1] For a succinct description of the main features of the seigniorial tenure, see Parkman's Old Régime, ch. 15; Garneau, i. 171–174.

[2] The seigniors rarely exercised their judicial rights; the Seminary of St. Sulpice was almost the only one to do so; the council exercised superior jurisdiction in all cases. Doutre et Lareau, pp. 133, 305.

[3] Parkman's Old Régime, p. 234.

[4] Edits et Ordonnances, i. 443. Doutre et Lareau, pp. 259, 260. Bouchette's Canada, p. 86.

[5] "The most important persons in a parish were the curé, the seignior, and the militia captain. The seignior had his bench of honour in the church. Immediately behind it was the bench of the militia captain, whose

exercised a considerable weight in the community, but not to the degree that the representative of the church enjoyed. From the earliest time in the history of the colony, we find the Roman Catholic church exercising a dominant influence—an influence, it must be admitted, discreetly and wisely used for the welfare of the people committed to its spiritual care.[1] Next to the curé in importance was the captain of militia, who was exceedingly useful in the absence of civil authorities in carrying out the orders and instructions of the government in the parishes. The whole province was formed into a militia district so that, in times of war, the inhabitants might be obliged to perform military service under the French governor. In times of peace, these militia officers executed the orders of the governor and intendant in all matters affecting the king. A captain was appointed for each parish, and in some of the larger divisions there were two or three.[2]

By reference to the numerous ordinances of the intendant, we can see pretty accurately how such local matters as the construction, maintenance, and repair of roads and bridges were managed in the seigniories and parishes. In case it was considered necessary to build a church or presbytery, the intendant authorized the *habitants* to assemble for the purpose of choosing from among themselves four persons to make, with the curé, the seignior, and the captain of the militia, an estimate of the expense of the structure. It was the special care of the captain of the militia to look after the work, and see that each parishioner did his full share.[3] It was only in church matters, in fact, that the people of a parish had a voice, and even in these, as we see, they did not take the initiative. The Quebec authorities must in all such cases first issue an ordinance.

All the roads and bridges of the colony were under the supervision of the *grand voyer*, or superintendent of highways, appointed by the king. We find in the proceedings of the council on the 1st of February, 1706, the regulations which governed this important officer in the discharge of his duties. He was obliged to visit all the seigniories at certain times of the year and make provision for the highways wherever necessary. The roads and other local improvements were constructed after consultation with the proprietors of lands and the most responsible persons of the place, at the expense of the people immediately interested. All the work was performed under the direction of the captain of militia in the parish.[4]

The position of the people in French Canada for a century and a half has been tersely set forth by the writers to whom we have frequently referred: "Without education, without an opportunity of taking part in public affairs, without an interest in the public offices, all of which were filled up by persons sent out by the Government, the Canadian people were obliged to seek, in the clearing of the forest, in the cultivation of the field, in the chase, and in adventure, the means of livelihood, and hardly ever busied themselves with public matters. Sometimes they thought they were becoming 'a people' on this

duty it was to drill the able-bodied men of the neighborhood. . . . . Next in honor came the local judge, if any there was, and the church-wardens." Parkman's Old Régime, p. 387. The precedence in church and processions was regulated by ordinance. See Doutre et Lareau, p. 242.

[1] "Lower Canada had, when we received it at the conquest, two institutions which alone preserved the semblance of order and civilisation in the community—the Catholic Church and the militia, which was so constituted and used as partially to supply the want of better civil institutions." Lord Durham's Report, p. 31.

[2] Doutre et Lareau, p. 136.

[3] Edits et ordonnances, ii. 295.

[4] Edits et ordonnances, ii. 135.

continent, and might acquire a larger degree of liberty, but all such aspirations were promptly checked by the governor, the intendant and the bishop, in obedience to the instructions of the king. No social union existed between the people, no guarantees for civil liberty were ever established. On every occasion the people were taught to have no ambition for civil power, or for a share in public businesss. Reduced at last to a state of passive obedience, they accepted the orders and edicts of the king without a murmur."[1]

It is easy to understand that the result of this autocratic, illiberal system of government was complete social and political stagnation.[2] It was not until the people of French Canada had been for many years under a British system of government, that they awoke to the full consciousness of their rights, and began to take that practical interest in public affairs which was the best evidence of their increased intelligence.

III.—Lower Canada, 1760–1840.

For three years after the conquest of Canada, the government was in the hands of military chiefs who had their headquarters at Quebec, Montreal and Three Rivers, the *chefs lieux* of the three departments into which General Amherst, the first English governor-general, divided the new province. During this military regime the people as a rule settled their difficulties among themselves, and did not resort to the military tribunals which were established to administer law throughout the conquered territory.[3] In 1763, King George III established four new governments in America, viz., Quebec, East Florida, West Florida, and Grenada. For nearly thirty years, the people of the government of Quebec were not represented in a legislature, but were governed up to 1774 by a governor-general, and an executive council, composed in the first instance, of the two lieutenant-governors of Montreal and Three Rivers, of the surveyor-general of customs, and of eight others chosen from leading residents of the province.[4] In 1774 the imperial parliament for the first time intervened in the affairs of the country, and passed the Quebec Act, by which the government was entrusted to a governor-general and a legislative council appointed by the crown, inasmuch as it was deemed "inexpedient to call an assembly." This irresponsible body was to contain not more than twenty-three and not less than seventeen members, and had power with the consent of the governor-general "to make ordinances for the peace, welfare, and good government of the province." It had no authority, however, to impose any taxes or duties, except such as the inhabitants of any town or district might be authorized to assess or levy within its precincts for the

[1] Doutre et Lareau, p. 308.

[2] "The institutions of France, during the period of the colonisation of Canada were, perhaps, more than those of any other European nation, calculated to repress the intelligence and freedom of the great mass of the people. These institutions followed the Canadian colonist across the Atlantic. The same central, ill-organized, unimproving and repressive despotism extended over him. Not merely was he allowed no voice in the government of the province, or the choice of his rulers, but he was not even permitted to associate with his neighbours for the regulation of those municipal affairs which the central authority neglected under the pretext of managing." Lord Durham's Report, p. 9.

[3] Attorney-general Thurlow's Report in Christie's History of Lower Canada, i. 49, 50.

[4] Christie, i. 49, 50.

purpose of making roads, erecting and repairing public buildings, or for any other purpose respecting the local convenience and economy of such town or district.[1]

During the military regime, the captains of militia dispensed justice and carried out the orders of the authorities in the parishes.[2] The king, in 1763, gave instructions to Governor Murray, who succeeded General Amherst, to lay out townships and provide town sites, with the view of encouraging the settlement of English-speaking people. Provision was also made for building a church, and for giving 400 acres of land to the support of a clergyman, and 200 acres for a schoolmaster.[3] In 1764 the governor established courts of quarter sessions for the trial of petty causes. These courts were composed of justices of the peace who had to address their warrants to the captains and other officers of militia in the first instance.[4] The majority of the inhabitants dwelling in each parish were also permitted to elect, on the 24th of June in each year, six men to act as *Baillis* and *Sous-Baillis.*[5] The names of these men were sent in to the deputy secretary of the province, and the governor-general, with the consent of the council, appointed the persons who were to act. These officers had for some years the inspection of the highways and bridges, and also acted as constables. In 1777, it was deemed advisable to pass an ordinance providing for the repair and maintenance of the roads and bridges in the province, under the direction of the *grand voyer*, whose office was reëstablished in accordance with the desire of the imperial government to continue the old institutions of the country, to which the people were accustomed. The old French system was practically again in force. The proprietors and farmers were required to keep up the roads and bridges that passed by their respective properties. All repairs were performed by statute labour or at the cost of the parish. The judges of common pleas on circuit were to report on the state of the communications, as provided for in the ordinance.[6]

In 1791 a very important constitutional change took place in the political condition of Canada. At the close of the American War of Independence, a large number of people known as United Empire Loyalists, on account of their having remained faithful to the British Crown during that great struggle, came and settled in the provinces. Some ten thousand persons, at least, made their homes in Upper Canada, while a considerable number found their way to the Eastern Townships which lie to the south of the St. Lawrence, between the Montreal district and the frontier of the United States. The Parliament of Great Britain then thought it advisable to separate the French and English nationalities by forming the two provinces on the St. Lawrence and the Great Lakes, known until 1867 as Lower Canada and Upper Canada. To the people of both sections were granted representative institutions.[7] By a proclamation of the governor-general, dated 7th of May, 1792, Lower Canada was divided, for legislative purposes, into the following twenty-one counties :—Bedford, Buckingham, Cornwallis, Devon, Dorchester, Effingham, Gaspé, Hampshire, Hertford, Huntingdon, Kent, Leinster, Montreal, St. Maurice, Northumberland,

[1] 14 Geo. III. c. 83; Bourinot's Parliamentary Procedure, ch. i. on Parliamentary Institutions in Canada, pp. 9-12.

[2] Doutre et Lareau, p. 485.

[3] *Ibid.*, p. 563.

[4] *Ibid.*, p. 589.

[5] *Ibid.*, p. 590.

[6] Ordinances for the Province of Quebec (Brown and Gilmore), p. 86.

[7] 31 Geo. III. c. 31; Bourinot, p. 14.

Orleans, Quebec, Richelieu, Surrey, Warwick, and York.[1] The names of some of these divisions recall well-known counties or shires in England.

The system of government established in 1791 continued in force until the suspension of the constitution of Lower Canada, as a consequence of the rebellion of 1837–8, under the leadership of Papineau and other men whose names are familiar to all students of Canadian political history. During these years, the country was practically governed by the governor-general and the executive and legislative councils, both nominated by the former. The popular house, however, had little influence or power as long as the government was not responsible to the people's representatives, and was indifferent to their approbation or support. The result was an irrepressible conflict between the assembly, and the legislative and executive councils supported by the governor-general. The fact was, the whole system of government was based on unsound principles. The representative system, granted to the people, did not go far enough, since it should have given the people full control over the public revenues and the administration of public affairs, in accordance with the principles of ministerial responsibility to parliament as understood in the parent state. More than that, it failed, because it had not been established at the outset on a basis of local self-government, as was the case in the United States, where the institutions of New England and other colonies had gradually prepared the people for a free system of government. Turning to the remarkable report on the affairs of Canada which bears the name of Lord Durham,[2] who was governor-general and high commissioner in 1839, we find the following clear appreciation of the weakness of the system in operation for so many years in the old provinces of Canada: "If the wise example of those countries in which a free and representative government has alone worked well, had been in all respects followed in Lower Canada, care would have been taken that, at the same time that a parliamentary system, based on a very extended suffrage, was introduced into the country, the people should have been entrusted with a complete control over their own local affairs, and been trained for taking their part in the concerns of the province by their experience in the management of that local business which was most interesting and most easily intelligible to them. But the inhabitants of Lower Canada were unhappily initiated into self-government at exactly the wrong end, and those who were not trusted with the management of a parish were enabled by their votes to influence the destinies of a state."[3]

The following divisions existed in Lower Canada, between 1792 and 1840, none of which, however, were constituted with a view to purposes of local government:—

1. Districts.
2. Counties.
3. Parishes.
4. Townships.

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[1] Bouchette's Topographical Description of Lower Canada, etc., p. 86. It appears that Nova Scotia was the first province in British North America to establish the old Norman division of "County," which is the equivalent of the Saxon "Shire."

[2] This remarkable document, it is now well understood, was written by Mr. Charles Buller, who accompanied Lord Durham in the capacity of secretary. "In fact written by Mr. Charles Buller, and embodying the opinions of Mr. Gibbon Wakefield and Sir William Molesworth on Colonial policy." Note by Mr. Reeve to Greville's Memoirs (second part), i. 142.

[3] Lord Durham's Report, p. 35.

The four districts were Quebec, Three Rivers, Montreal, and St. Francis, which were established for purely judicial purposes. The courts therein had unlimited and supreme original jurisdiction. In addition to these superior districts there was the inferior division of Gaspé with a limited jurisdiction.

The counties were, as I have already intimated, established for parliamentary objects; for Lord Durham observed that he knew "of no purpose for which they were constituted, except for the election of members for the house of assembly."[1] The parishes, into which the seigniories were divided, were the old divisions established in the days of the French regime. The limits of the parishes, as set forth in the ordinance of 1721, were not strictly adhered to as the population spread, and settlements became more numerous. It was consequently found necessary from time to time to build many new churches, that the means and accommodation for religious worship might keep pace with the numerical increase of the congregations. For the support of these churches, portions of ancient parishes were, as the occasion arose, constituted into new ones.[2] The townships were established a few years after the Conquest, principally for surveying purposes, in order to meet the requirements of the considerable English population that in the course of time flowed into Upper and Lower Canada.[3]

The people that dwelt in the local divisions had no power to assess themselves for local improvements, but whenever a road or bridge was wanted it was necessary to apply to the legislature. In consequence of this, the time of that body was constantly occupied with the consideration of measures, which should have been the work of such local councils as existed in different parts of the United States. The little schemes and intrigues into which the representatives of different localities entered in order to promote and carry some local work and make themselves popular with their constituents gave rise to a great deal of what is known, in American parlance, as "log-rolling." "When we want a bridge, we take a judge to build it" was the forcible way, according to Lord Durham's Report,[4] in which a member of the provincial legislature described the tendency in those days to retrench on the most important departments of the public service in order to satisfy the pressing demands for local works.

It would be supposed that the British-speaking people of the townships, whose early lives had been passed in the midst of the liberal local institutions of the old British Colonies, would have been desirous of introducing into their respective districts at least a semblance of municipal government. We look in vain, however, for such an effort on their part. They appear to have quietly acquiesced in a state of things calculated to repress a spirit of local enterprise and diminish the influence of the people in the administration of public affairs. Indeed, we have some evidence that the government itself was prepared for many years to discourage every attempt to introduce into Canada anything like the local system that had so long existed in New England. British statesmen probably remembered the strong influence that the town-meetings of Boston had in encouraging a spirit of rebellion, and thought it advisable to stifle at the outset any aspirations that the Canadian colonists might have in the direction of such doubtful institutions. "I understand," wrote Mr. Richards in a report to the secretary of state for the

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[1] Report, p. 35.
[2] Bouchette, p. 86.
[3] Bouchette, p. 87; Lord Durham's Report, p. 36.
[4] Report, p. 29.

colonies, ordered by the house of commons to be printed as late as March, 1832, "that the Vermonters had crossed the line and had partially occupied several townships, bringing with them their municipal institutions; and that when the impropriety of electing their own officers was pointed out to them, they had quietly given them up, and promised to conform to those of Canada." [1]

While the legislature was, to all intents and purposes, a large municipal council for the initiation and supervision of all local improvements, the affairs of the different parishes and townships were administered as far as consonant with the old French system. The *grand voyer* and militia captain continued to be important functionaries in the administration of local affairs. All the highways and bridges had to be repaired and maintained under the direction of the *grand voyer* or his deputy. Whenever it was necessary to open up a new road or to change an old one, it was the duty of these officials, on receiving a petition from the locality, to call a public meeting with reference to the matter, by a notice published at the parish church door after the morning service. The *grand voyer* or his deputy had the power of dividing every parish, seigniory, or township, into such sections as he should think proper, and allot to each an overseer of highways and bridges, to be chosen at a meeting of householders, called and presided over by the eldest captain or senior officer of militia. These meetings were held in the public room of the parsonage of the parish, or at such other place as the captain of militia might direct. The *grand voyer* had alone the power of appointing a surveyor of roads and of considering and deciding on reports made by such officers to him on the subject of highways. It was the duty of the justices of the peace, assembled in quarter sessions, to hear and adjudicate on all questions that might arise under this law. The same regulations, however, did not apply to the cities and parishes of Quebec and Montreal. Here the justices of the peace in sessions had practically the regulation of highways, streets, and local improvements, and appointed all the officers necessary to carry out the same. They also fixed and determined the sums of money that had to be paid for such purposes.[2]

As a matter of fact, the *grands voyers*, who lived in Quebec, Montreal and Three Rivers, had no very onerous functions to discharge. The people of the parishes and townships learned to depend on the legislature and only performed the work imposed on them by the law regulating statute labour. The absence of effective municipal institutions was particularly conspicuous in the cities of Quebec and Montreal, where it would be expected that more public spirit would be shown. "These cities," I again quote from Lord Durham's Report,[3] "were incorporated a few years ago by a temporary provincial act of which the renewal was rejected in 1836. Since that time these cities have been without any municipal government and the disgraceful state of the streets and the utter absence of lighting are consequences which arrest the attention of all and seriously affect the comfort and security of the inhabitants."

In every matter affecting the administration of civil and judicial affairs there appears to have been a remarkable absence of anything approaching a workable system by which the people might manage their affairs. More than that, there was actually an insufficiency of public officers for the administration of justice. Outside the cities, the machinery

[1] Lord Durham's Report, p. 36. [2] See Lower Canada Statutes, 1796. [3] Report, p. 36.

of civil government was singularly defective. A sheriff was appointed only for each of the four judicial districts. Neither sheriffs nor constables nor parochial officers could be found in the majority of the counties of the province. It is true there were a number of justices of the peace who assembled in quarter sessions in accordance with the system so long in vogue in England and her colonies, but these men were appointed without much regard to their qualifications for the position and even the permanent salaried chairmen, appointed by the crown, were in the course of time abolished by the legislature, and these inferior courts consequently deprived of the services of men generally of superior attainments.[1] Practically, the affairs of each parish were regulated by the curé, the seignior and the captain of militia, as in the days of French government. Thanks to the influence of these men, peace and order prevailed. Indeed as we review the history of French Canada in all times, we cannot pay too high a tribute to the usefulness of the French Canadian clergy in the absence of the settled institutions of local government. In fact, it was only in ecclesiastical affairs that the people ever had an opportunity of exercising a certain influence. The old institution of the *fabrique*—which still exists[2] in all its vigour—enabled them to meet together whenever it was necessary to repair a church or presbytery. When the religious services were over, the people assembled at the church door and discussed their affairs.

No doubt the influences of the old French Regime prevailed in Lower Canada for a long while after the conquest. A people whose ancestors had never learned the advantages of local self-government, would be naturally slow to awake to the necessity of adopting institutions under which the American colonists had flourished. It may be true, as Mr. Parkman says, that the French colonists, when first brought to America, could not have suddenly adopted the political institutions to which the English-speaking colonists at once had recourse as the natural heritage of an English race. It is still more true, as the eminent American historian adds, that the mistake of the rulers of New France "was not that they exercised authority, but that they exercised too much of it, and instead of weaning the child to go alone kept him in perpetual leading strings, making him, if possible, more and more dependent, and less and less fit for freedom." When the French Canadian became subject to the British Crown, he was, literally, a child who had never been taught to think for himself in public affairs. He was perfectly unskilled in matters appertaining to self-government, and had no comprehension whatever of that spirit of self-reliance and free action which characterizes the peoples brought up under Teutonic and English institutions. In the course of time, however, the best minds among them began to appreciate fully the advantages of free government, and to their struggles for the extension of representative government, the people of British North America owe a debt of gratitude. It took a long while, however, to educate the people of

[1] Lord Durham's Report, p. 39.

[2] The law still makes special provision for the erection and division of parishes, the construction and repair of churches, parsonages, cemeteries and for the meeting of fabriques. Every decree for the canonical erection of a new parish, or for the subdivision, dismemberment or union of any parishes, or with regard to the boundaries of parishes, must be publicly read from the pulpit or chapel of the parish, and other formal steps taken to notify the inhabitants of the proposed measure, before commissioners appointed by the state can give civil recognition to the decree. On the *procès verbal* of these officers, the lieutenant-governor may issue a proclamation under the great seal of the province, erecting such parish for civil purposes. See Consol. Stat. Low. Can., c. 18, and amending Statutes.

French Canada up to the necessity of establishing a liberal system of municipal institutions. As we shall see, before the close of this paper, it was not until after the Union of 1840 that the French Canadians could be brought to acknowledge the benefits of local taxation imposed by their own local representatives. In this respect, they made less progress than the people of Upper Canada, to whose history we shall now proceed to refer.

IV.—Upper Canada, 1792—1840.

As I have already stated, Upper Canada was settled by United Empire Loyalists, who came into the country after the War of Independence. The majority of these people settled on the shores of Lake Ontario, in the vicinity of Kingston and the Bay of Quinté, in the Niagara district, and in other favoured localities by Lakes Ontario and Erie.[1] On the 24th of July, 1788, the governor-general issued a proclamation [2] constituting the following districts in Western or Upper Canada, viz., Luneburg, Mecklenburg, Nassau, Hesse.

Luneburg comprised the towns or tracts known by the names of Lancaster, Charlottenburg, Cornwall, Osnabruck, Williamsburg, Matilda, Edwardsburg, Augusta and Elizabethtown. Mecklenburg comprised Pittsburg, Kingston, Ernestown, Fredericksburg, Adolphustown, Marysburg, Sophiasburg, Ameliasburg, Sydney, Thurlow, Richmond, and Camden. Nassau comprised the extensive district which extends from Trent to Long Point on Lake Erie, and Hesse, the rest of the western part of Canada to Lake St. Clair.[3] To each of these districts were appointed a judge and a sheriff, and justice was administered in courts of common pleas. The justices were taken from the best men the country offered in the absence of persons of legal attainments.[4] The judges in those primitive times seem to have possessed almost absolute power.

The first local divisions of Upper Canada appear to have been the townships. The British Government was extremely liberal in its grants of land to the Loyalists and the officers and soldiers who settled in Upper Canada and the other provinces. The grants were made free of expense on the following scale: to a field officer, 5,000 acres; to a captain, 3,000; to a subaltern, 2,000; to a private, 200. Surveys were first made of the lands extending from Lake St. Francis, on the St. Lawrence, to beyond the Bay of Quinté. Townships were laid out and divided into concessions and lots of 200 acres. Each township generally extended nine miles in front and twelve in the rear, and varied from 80,000 to 40,000 acres. The townships were not named for many years, but were numbered in two divisions.[5] One

[1] Ryerson's Loyalists in America, ii. 189.

[2] See Proclamation in Collection of Acts and Ordinances relating to Upper Canada, York, 1818. Luneburg is correctly spelt in the Proclamation, but in course of time it became, for some unexplained reason, "Lunenburg." The name still survives in the changed form in Nova Scotia.

[3] Canniff's History of the Settlement of Upper Canada, p. 62; also foregoing Proclamation.

[4] Judge Duncan of Luneburg was a storekeeper and a captain in the militia; he dealt out law, dry goods and groceries alternately. *Ibid.*, p. 506.

[5] Canniff; Ryerson, ii. 224-5. Dr. Scadding, Toronto of Old, p. 362, gives an amusing account of the frivolous way in which many of the old Townships of Upper Canada were named in the course of years. Flos, Tay and Tiny, which are names of three now populous townships in the Penetanguishene district, are a commemoration of three of Lady Sarah Maitland's lapdogs. Some one wrote *Jus et Norma*, as a joke, across a plan of a newly surveyed region, and three townships were consequently known as "Jus", "Et", and "Norma" for years until they were changed to Barrie, Palmerston and Clarendon respectively. "Aye," "Yea," and "No" were also designations of local divisions.

division embraced the townships below Kingston on the St. Lawrence, and the other the townships westward to the head of the Bay of Quinté. One of the first settlers of Upper Canada has given us the following description of the mode in which the townships were granted by the government:—

"At length the time came in July, for the townships to be given out. The governor came and having assembled the companies before him, called for Mr. Grass, and said, Now you were the first person to mention this fine country, and have been here formerly as a prisoner of war. You must have the first choice. The townships are numbered, first, second, third, fourth and fifth; which do you choose?' 'The first township' (Kingston). Then the governor says to Sir John Johnson, 'Which do you choose?' He replies, 'The second township' (Ernestown). To Colonel Rogers, 'Which do you choose?' He says 'The third' (Fredericksburg). To Major Vanalstine, 'Which do you choose?' 'The fourth' (Adolphustown). Then Colonel McDonell got the fifth township, (Marysburg). So, after this manner, the first settlement of Loyalists in Upper Canada was made."[1]

The districts which were constituted in 1788 were intended mainly for judicial purposes, and were named after great houses in Germany, allied to the royal family of England. The same was the case with the first townships that were laid out. The first township was called Kingstown, after His Majesty George III; Ernestown after Ernest Augustus, eighth child of the King; Adolphustown, after another son.[2] Provision was made for future towns during the first surveys. A plot was generally reserved in some locality which seemed especially adapted for a town. This was the case in Adolphustown, where a lot was granted to each of the settlers. But towns were of very slow growth, until some years after the establishment of a separate government in Upper Canada, when settlers began to flow steadily into a country whose fertility and productiveness commenced at last to be understood. Not a few of the towns owe their establishment to private enterprise and prescience in the first instance.[3]

In 1791 Upper Canada was separated from French Canada, and became a province with a legislature composed of a lieutenant-governor, a legislative council appointed by the Crown, and a legislative assembly elected by the people.[4] When lieutenant-governor Simcoe undertook the administration of the affairs of the new province, he issued a proclamation dividing it into nineteen counties, as follows: Glengary, Stormont, Dundas, Grenville, Leeds, Frontenac, Ontario, Addington, Lenox, Prince Edward, Hastings, Northumberland, Durham, York, Lincoln, Norfolk, Suffolk, Essex, and Kent.[5] Some of

[1] Ryerson, ii. 209.

[2] "King George III. who died in 1820, aged 82, having reigned 60 years, had a family of 15 children, whose names were George, Frederick, William Henry, Charlotte Augusta, Matilda, Edward, Sophia Augusta, Elizabeth, Ernest Augustus, Augustus Frederick, Adolphus Frederick, Mary Sophia, Octavius, Alfred, and Amelia. These royal names were appropriated to the townships, towns, and districts." Canniff, p. 439.

[3] "Windsor (now Whitby) was so named about 1819 by its projector, Mr. John Scadding, the original grantee of a thousand acres in this locality. On a natural harbour of Lake Ontario, popularly known as Big Bay, Mr. Scadding laid out the town, built the first house, and named the streets, three of them after his three sons—John, Charles and Henry." Ryerson, ii. 260. One of these sons, here mentioned, is the well known antiquarian of Toronto, Rev. Dr. Scadding.

[4] 31 Geo. III, c. 31.

[5] See Proclamation in Statutes of Upper Canada, i. 23.

the well settled counties were divided into ridings,[1] each of which sent a representative to the legislature. In other cases one representative was elected for two or more counties. One of the first acts of the legislature was to change the names of the four divisions established in 1788 to the Eastern, Midland, Home, and Western Districts.[2] In the course of years the number was increased by the addition of the Johnstown, Newcastle, Niagara, London and Gore Districts.[3] These districts were intended mainly for legal and judicial purposes. But all these old names, so familiar in provincial history, have become obliterated by the county organisations.

The Duke de la Rochefoucault-Liancourt, who visited the country in 1795, and had several interviews with Governor Simcoe, at Newark, now Niagara, the old capital of Upper Canada, informs us that the division of the four districts into counties was "purely military, and related merely to the enlisting, completing and assembling of the militia. The militia of each county is commanded by a lieutenant."[4] Whilst the Duke was, no doubt, correct in the main, it must not be forgotten that the erection of counties was also necessary for purposes of representation. A section of the act establishing the Constitution of Upper Canada expressly provided: His Majesty may authorise "the governor or lieutenant-governor of each of the provinces of Upper and Lower Canada to issue a proclamation dividing such province into districts or counties or circles, towns and townships, and appointing the limits thereof, and declaring and appointing the number of representatives to be chosen by each of such districts, counties or circles, towns and townships respectively."[5] Members for the legislature were then, and for many years afterwards, chosen by freeholders having real property to the yearly value of forty shillings in districts, counties or circles, and five pounds sterling in towns and townships, or who paid a rental in the latter at the rate of ten pounds sterling a year.[6]

The legislature was composed of plain, practical men, who went energetically to work in the first sessions to provide for the wants of the few thousands of people scattered throughout the wide extent of country over which their jurisdiction reached. For many years their principal duties were confined to measures for carrying on local improvements. It was considered "requisite, for the maintenance of good order and the rigid execution of the laws, that proper officers should be appointed to superintend the observance thereof."[7] Accordingly, the people were authorised by statute to meet in any parish, township or reputed township or place on the warrant of the high-constable, who was to preside on such occasions. These assemblies were composed of the inhabitants who were householders and ratepayers in the locality interested, and were held in the early times, for convenience sake, in the parish church or chapel. They had to elect a parish or town clerk, who was to make out annual lists of the inhabitants within a district, keep the records, and perform other business connected with such an office. The other officers appointed were as follows: assessors, to assess all such rates and taxes "as shall be imposed by any act or acts of the legislature;" a collector, "to receive such taxes and

[1] Trithings or Ridings were divisions peculiar to Yorkshire and Lincolnshire, though Robertson (Scotland under her early Kings, iii. 433) is inclined to trace them in Kent and Surrey. Bishop Stubbs, however, (Constitutional History, i. 100) considers the view "very interesting but very conjectural."

[2] Upp. Can. Stat. 32, Geo. III. c. 8.

[3] Bouchette, p. 590. Scadding's Toronto, p. 361.

[4] De la Rochefoucault-Liancourt, Voyage dans les Etats Unis et le Haut Canada, i. 434.

[5] 31 Geo. III, c. 31. s. 14.

[6] Imp. Stat. 31 Geo. III, c. 31.

[7] Upp. Can. Stat. 33 Geo. III, c. 2.

rates in the manner authorised by the legislature;" overseers of roads and highways, "to oversee and perform such things as shall be directed by any act passed touching or concerning the highways and roads in the province," and to act as fence-viewers "conformable to any resolutions that may be agreed upon by the inhabitants at such meetings"; a pound-keeper, to impound all stray cattle. The act also provided for two town-wardens. As soon as there should be any church built for the performance of divine service according to the use of the Church of England, then the parson or minister was to nominate one warden and the inhabitants the other. These wardens were a corporation to represent the whole inhabitants of the township or parish, with the right to let or sell property, to sue and be sued. The high-constable, who called and presided over the township meetings, was appointed by the justices in quarter sessions. The presiding officer had to communicate a list of persons nominated at these meetings to a magistrate, who was to administer to them the oath of office. In case the persons appointed at the meeting refused to act, they were subject to a penalty, and the magistrates in sessions called for that purpose proceeded to fill the vacancies. In case there were not thirty inhabitants in a township, then they were considered to form part of the adjacent township which should contain the smallest number of inhabitants.[1]

The following extract from the early records of the township of Sophiasburg, or the 6th township lying on Picton and Quinté Bays, will be read with interest, because it shows that there was an attempt made to establish a parish system on the basis of that so long existent in the parent state. No similar record can be found in the annals of the old townships of Upper Canada, although the references in the Constitutional Act of 1791, and in several provincial statutes,[2] go to show that the erection of parishes was in the minds of those who were engaged in developing local institutions in the country:—

"Passed at Sophiasburg, at a regular town meeting, 3rd March, 1800. And be it observed—That all well-regulated townships be divided into parishes. Be it enacted by the majority of votes, that this town shall be divided into parishes, and described as follows: St. John's, St. Matthew's, St. Giles, Mount Pleasant." [3]

It does not appear, however, that parishes were established to any extent on the English system throughout Upper Canada, although they were general for ecclesiastical purposes. The Church of England was the dominant religious body for many years, and there was an effort made to establish it by giving it large reserves of public lands. We shall see, however, later on, that parishes were established in the maritime provinces for civil purposes as in some of the old English colonies in America.

In accordance with the British system of local government in counties, the magistrates in sessions performed an important part in the administration of local affairs.

[1] One of the first recorded town meetings (Canniff, p. 454) held in accordance with the act, was that of Adolphustown, which came off on the 6th of March, 1793. The following words are an exact transcript of the record:—"The following persons were chosen to officiate in their respective offices, the ensuing year, and also the regulations of the same: Reuben Bedell, township clerk; Paul Huff and Philip Dorland, overseers of the poor; Joseph Allison and Garit Benson, constables; Willet Casey, Paul Huff and John Huyck, pound-keepers; Abraham Maybee and Peter Rutland, fence-viewers. The height of fence to be 4 feet 8 inches; water fence voted to be no fence. Hoggs running at large to have yokes on 18 by 24 inches. No piggs to run until three months old. No stallion to run. Any person putting fire to any bush or stable, that does not his endeavour to hinder it from doing damage, shall forfeit the sum of forty shillings." (Signed) PHILIP DORLAND, T. Clerk.

[2] See before, p. 58.

[3] Canniff, p. 472.

These courts of quarter sessions have long existed in English counties, and their functions have been regulated by a series of statutes commencing in the Tudor times and coming down to the present day. The English counties were subdivided into petty sessional divisions. At the head of this civil organisation in a county is the lord-lieutenant and the *Custos Rotulorum.* These two offices are usually held by one person, who holds office under a special commission from the Crown, and is generally a peer of the realm or large land-owner.[1] "His office," says Hallam, "may be considered as a revival of the ancient local earldom, and it certainly took away from the sheriff a great part of the dignity and importance which he had acquired since the discontinuance of that office. Yet the lord-lieutenant has so peculiarly military an authority that it does not in any degree control the civil power of the sheriff as the executive minister of the law."[2]

It would appear from the old records that there was a similar officer appointed in the early times of Canada. Speaking of Lower Canada, Lord Durham says: "The justices of the peace scattered over the whole of Lower Canada are named by the governor on no very accurate information, there being no lieutenants or similar officers of counties in this as in the upper province."[3] The Duke de la Rochefoucault, writing in 1795, says: "Simcoe is by no means ambitious of investing all power and authority in his own hands, but consents that the *lieutenants*, whom he nominates for each county, should appoint the justices of the peace and officers of the militia."[4] From these and other references to the duties of the officer, he appears to have discharged functions similar to those of the lord-lieutenant in England, since he appointed justices and commanded the militia. The title, however, appears to have fallen into disuse in the course of a few years, though there was a custos rotulorum or chairman of sessions in all of the provinces. The lieutenancy in Upper Canada never assumed as much importance as did the same office in Virginia.[5]

As I have already shown, the justices in sessions appointed as in England a high constable, and discharged certain functions now performed by municipal bodies in Canada. All moneys collected by assessors of taxes were to be paid into the hands of treasurers who were appointed by the justices in general quarter sessions. The justices so assembled directed how the moneys were to be disbursed in accordance with the law. The legislature, from time to time, regulated the time and place for holding these courts. The quarter sessions were held in 1793, at Adolphustown, Kingston, Michillimackinac, Newark, New Johnstown, and Cornwall, then the principal towns of the province. The jurisdiction of the justices was very extensive in those times. They had the carrying out in a great measure of the acts of the legislature providing for the defraying of the expenses of building court houses and jails, of keeping the same in repair, of the payment of jailers, of the support and maintenance of prisons, of the building and repairing of houses of correction, of the construction and repairs of bridges, of the fees of coroners and other officers,

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[1] The English Citizen Series. Local Government in England, M. D. Chalmers, p. 93.

[2] Const. Hist., (Eng. ed. 1881) ii. 134. [3] Report, p. 41. [4] Vol. i. 416.

[5] "One is struck by the prominence of the lieutenant, anciently the commander, who, besides being the chief of the militia in his county, was a member of the Council, and as such a judge of the highest tribunal in the county. With Commissioners of the Governor he held monthly courts for the settlement of suits, not exceeding in value one hundred pounds of tobacco, and from this court, appeal was allowed to the Governor and Council." Local Institutions of Virginia. By Ed. Ingle (Johns Hopkins University Studies in Historical and Political Science) p. 83.

and of all other matters that were essentially of a local character. Whenever it was necessary to establish a market, the legislature had to pass a special act giving the requisite power to the court of sessions. For instance, we find an act authorising the justices in this court "to fix, open and establish some convenient place in the town of Kingston as a market, where butcher's meat, butter, eggs, poultry, fish and vegetables, shall be exposed to sale, and to appoint such days and hours as shall be suitable for that purpose, and to make such other orders and regulations relative thereto as they shall deem expedient."[1] The justices of the peace had also other important functions to discharge out of the sessions. For instance, it was on their certificate that the secretary of state granted licenses to public houses. These licenses were only granted after full inquiry and discussion at public meetings duly called for that purpose by the high constable or other public officer.[2] The justices in quarter sessions also appointed surveyors of highways to lay out, and regulate statute labour on the public roads. All persons were liable to work on the roads, in proportion to the assessment on their real and personal property.[3]

For the first fifteen or twenty years of the history of the administration of civil affairs in Upper Canada, the burdens of the people were exceedingly small. A Canadian historian says on this point: "No civilised country in the world was less burdened with taxes than Canada West at this period. A small direct tax on property, levied by the district courts of sessions, and not amounting to £3,500 for the whole country, sufficed for all local expenses. There was no poor rate, no capitation tax, no tithes, no ecclesiastical rates of any kind. Instead of a road tax, a few days of statute labour annually sufficed."[4]

Under such circumstances we can easily understand why the condition of Kingston, for many years the most important town of Upper Canada, should have been so pitiable according to a writer of those early times: "The streets [in 1815] require very great repairs, as in the rainy seasons it is scarcely possible to move about without being in mud to the ankles. Lamps are required. . . . But first the legislature must form a code of laws, forming a complete police. To meet expense, government might lay a rate upon every inhabitant householder in proportion to value of property in house."[5] Subsequently, when Kingston became the seat of government, the municipal authorities were encouraged to make improvements in streets, drainage, sidewalks, and otherwise. When the town of York was incorporated as a city, in 1834, under the name of Toronto, it had not a single sidewalk within its limits, and the first mayor, Mr. W. Lyon Mackenzie, had to initiate a system of local improvements under great difficulties.[6]

As the country filled up, and the necessity arose for roads and bridges and other local improvements, the taxes increased; although they never became heavy under the unsatisfactory system that prevailed, until after the reunion of the Canadas in 1841. The time of the legislature was constantly occupied in passing acts for the construction of public works necessary for the comfort, safety and convenience of particular localities. A large amount of "parish" business was transacted in those days by the legislature which might as well have been done by local councils. As compared with Lower Canada, how-

[1] Upp. Can Stat. 41 Geo. III, c. 3.
[2] *Ibid.*, 34 Geo. III, c. 12
[3] *Ibid.*, 48 Geo. III, c. 12.
[4] McMullen's History, p. 247.
[5] Canniff, p. 432.
[6] Lindsey's Life of Mackenzie, i. 312.

ever, the people had eventually a workable system of local government, which enabled them to make many improvements for themselves. The construction of canals and other important works of provincial importance, on an expensive scale, at last left so little funds in the treasury that the parliament of this province alone, among the North American colonies "was, fortunately for itself, compelled to establish a system of local assessment, and to leave local works in a great measure to the energy and means of the localities themselves."[1] Still the system, as the country became more populous and enterprising, proved ultimately quite inadequate to meet the requirements of the people and to develop their latent energies. The legislature was constantly called upon to give power to local authorities to carry out measures of local necessity. Whatever taxation was necessary for local purposes had to be imposed through the inconvenient agency of courts of quarter sessions, over which the people exercised little or no control. If the people of a city or town wished to be incorporated, they were forced to apply to the legislature for a special act. The powers granted to these corporations were by no means uniform, and great confusion resulted from the many statutes that existed with respect to these bodies. "No lawyer," says a writer on the subject,[2] "could give an opinion upon the rights of an individual in a single corporation without following the original act through the thousand sinuosities of parliamentary amendment, and no capitalist at a distance could credit a city or town without a particular and definite acquaintance with its individual history." It was not, however, until after the reunion of the Canadian provinces, that steps were taken to establish in Upper Canada a larger system of popular local government in accordance with the wise suggestions made by Lord Durham and other sagacious British statesmen. But before we can refer to this part of the subject, I must first review the early local history of the maritime provinces of Nova Scotia, New Brunswick, and Prince Edward Island.

V.—The Maritime Provinces.

When Nova Scotia became a possession of England by the treaty of Utrecht in 1713, the only place of any importance was Port Royal, originally founded by a French gentleman-adventurer, Baron de Poutrincourt. The English renamed the place "Annapolis Royal," in honour of Queen Anne, and for some years it was the seat of government. The province in those days had a considerable French Acadian population, chiefly settled in the Annapolis valley, and in the fertile country watered by the streams that flow into the Bay of Fundy. For some years there was a military government in Nova Scotia. In 1719, the governor received instructions to choose a council for the management of civil affairs from the principal English inhabitants, until an assembly would be formed to regulate matters in accordance with the instructions given to the American colonies generally. This first council was composed exclusively of officers of the garrison and of officials of the public departments. The French inhabitants in their respective parishes were permitted, in the absence of duly appointed magistrates, to choose deputies from among themselves for the purpose of executing the orders of the government and acting as

[1] Lord Durham's Report, p. 48.

[2] J. Sheridan Hogan, Prize Essay on Canada, 1885, p. 104.

arbitrators in case of controversies in the French settlements. An appeal was allowed to the governor at Annapolis.[1]

In 1749, the city of Halifax was founded by Governor Cornwallis on the shores of Chebucto Bay, on the Atlantic coast. The government of the province was vested in a governor and council, and one of their first acts was to establish a court of general sessions, similar in its nature and conformable in its practice to the courts of the same name in the parent state.[2] In 1751 they passed an ordinance that the town and suburbs of Halifax be divided into eight wards, and the inhabitants empowered to choose annually the following officials "for managing such prudential affairs of the town as shall be committed to their care by the governor and council:—eight town-overseers, one town-clerk, sixteen constables, eight scavengers.[3]

It was only after the establishment of the first legislature that Nova Scotia was divided into local divisions for legislative, judicial, and civil purposes. The first House of Assembly, elected in 1758, was composed of twenty-two representatives, of whom sixteen were chosen by the province at large, four by the township of Halifax, and two by the township of Lunenburg. It was at the same time provided that whenever fifty qualified householders were settled at Pisiquid (now Windsor), Minas, Cobequid, or at any other township which might be thereafter erected, it should be entitled to send two representatives to the assembly.[4] In 1759, the governor and council divided the province into five counties: Annapolis, Kings, Cumberland, Lunenburg and Halifax.[5] A few years later the whole island of Cape Breton was formed into a county.[6]

The legislature appears to have practically controlled the administration of local affairs throughout the province, except so far as it gave, from time to time, certain powers to the courts of quarter sessions to regulate taxation and carry out certain public works and improvements. In the first session of the legislature, a joint committee of the council and assembly choose the town officers for Halifax, viz., four overseers of the poor, two clerks of the market, four surveyors of the highways, two fence viewers, and two hog-reeves.[7] We have abundant evidence that at this time the authorities viewed with disfavour any attempt to establish a system of town government similar to that so long in operation in New England. On the 14th of April, 1770, the governor and council passed a resolution that "the proceedings of the people in calling town-meetings for discussing questions relative to law and government and such other purposes, are contrary to law, and if persisted in, it is ordered that the parties be prosecuted by the attorney-general."[8] The government of Nova Scotia had before it, at this time, the example of the town-meetings of Boston, presided over by the famous Samuel Adams, and doubtless considered them as the very hotbeds of revolution.[9] What the Tories thought of these popular bodies can be

[1] Haliburton's History of Nova Scotia, i. 93, 96.

[2] *Ibid.*, p. 163.

[3] Murdoch's History, ii. 199.

[4] Haliburton, i. 208. Murdoch, ii. 334, 351.

[5] Murdoch, ii. 373,374. In the election for the Assembly that came off in August of the same year, the counties in question returned two members each; the towns of Lunenburg, Annapolis, Horton, and Cumberland, two each, and the township of Halifax, four, or twenty-two representatives in all.

[6] *Ibid.*, p. 454.

[7] *Ibid.*, p. 361.

[8] Haliburton, i. 248.

[9] Bancroft very truly considers Samuel Adams more than any other man, "the type and representative of the New England town-meeting." History of the Constitution, ii. 260. For an interesting account of his career, see Samuel Adams, the Man of the Town Meeting, by J. K. Hosmer. Here the reader will be able to obtain a very accurate idea of the important influence that Adams and the town-meetings of Boston exercised over the destinies of America. No wonder was it that the governing class in Halifax frowned upon all manifestations of popular feeling in the province.

understood from the following extract, which gives the opinion of a rabid writer of those revolutionary times. "This is the foulest, subtlest, and most enormous serpent ever issued from the egg of sedition. I saw the small seed when it was implanted; it was a grain of mustard. I have watched the plant until it has become a great tree."[1]

In the course of time the province was divided for legislative, judicial and civil purposes, as follows:—

1. Divisions or circuits, generally consisting of one or more counties, for purposes connected with the courts.

2. Districts, generally of one or more townships, established, as a rule, for the convenience of the people, who had the privilege conferred upon them of having a court of sessions of the peace for the regulation of their internal affairs.

3. Counties, generally established for legislative purposes.

4. Townships, which were simply subdivisions of the county intended for purposes of local administration or of representation.

In each county there was a sheriff and justice of the peace, whose jurisdiction extended throughout the same. Each district was generally provided with a court house which belonged to the county. The townships did not contain any definite quantity of land, as was generally the case in Upper Canada. The inhabitants appear, according to Judge Haliburton, "to have had no other power than that of holding an annual meeting for the purpose of voting money for the support of the poor."[2] Up to very recent times, the justices in sessions were practically the local governing bodies in the various divisions of the province. Even Halifax was not allowed a special act of incorporation as a city until 1841, although its people made frequent applications to the legislature for power to manage their own affairs.[3] The time of the legislature was taken up with making provision for local wants. All the roads and bridges were built and maintained, and the public schools supported by the legislature. The system that so long prevailed, by which members of the legislature controlled the expenditures for local works, was well calculated to demoralize public men and encourage speculation and jobbery. Large sums were frittered away by the appointment of road commissioners with reference only to political considerations.[4] It was one well adapted to stimulate the energies of village politicians, and the spirit of party in the counties.

As respects local affairs, the people had little or no voice. The grand jury, in the court of sessions of the peace, annually nominated such number of persons for town officers as the justices should direct, and out of them the latter made the appointments.

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[1] Daniel Leonard, cited by Hosmer, p. 45. [2] Haliburton's Hist., ii. 8, 9.

[3] Murdoch, ii. 449. In 1850 Mr. Howe attempted to pass a bill dividing the county of Halifax into townships, and conferring certain municipal privileges upon the inhabitants. The people were to have the power to raise funds by assessment for the support of education and for other public purposes, and to elect their own township officers, including magistrates. Lord Grey, however, took exception to the measure, and the Queen's assent was withheld. Speeches and Public Letters of Hon. Joseph Howe, i. 642.

[4] "According to a report presented to me by Major Head, an assistant commissioner of enquiry whom I sent to that colony [Nova Scotia], a sum of £10,000 was, during the last session, appropriated to local improvements; this sum was divided into 830 portions, and as many commissioners were appointed to expend it, giving, on an average, a commissioner for rather more than every £12, with a salary of 5s. a day, and a further remuneration of two and a half per cent. on the money expended, to be deducted out of each share." Lord Durham's Report, p. 29. This demoralising and wasteful system lasted until very recently in Nova Scotia.

The grand jury had also the power to raise money for certain public purposes within a particular division. Of their own knowledge, or on the representation of three freeholders, they could make presentments for money for building or repairing jails, court-houses, pounds, or for other necessary local purposes. In the event of their neglecting to act, in certain cases the justices in sessions could amerce the county. The officers appointed at the sessions were a county treasurer and assessors. The clerk of the peace, as in England, was appointed by the custos, as chairman of the sessions; the office of sheriff was a government appointment. Practically, in Nova Scotia, as in the other provinces, the English county system prevailed.

If we now turn to the province of New Brunswick, we find that a similar system existed until very recently. This province originally formed part of the extensive and ill-defined territory known in French times as "Acadie." For some years it was governed by the governor and council of Nova Scotia, until the settlement of a large number of Loyalists on the banks of the St. John River brought about a change in its political constitution. Then the imperial authorities thought it expedient to create a separate province, with a government consisting, in the first instance, of a governor and council of twelve members, exercising both executive and legislative powers, and, eventually, of an assembly of twenty-six members.

On the 18th of May, 1785, a charter was granted by Governor Carleton for the incorporation of Parr Town, on the east side of the St. John River, and of Carleton, on the west side, as a city under the name of St. John. The inhabitants were given a mayor, recorder, six aldermen and six assistants, and the city was divided into six wards.[1] St. John, consequently, was the first city incorporated in British North America, and it remained so for many years, as Halifax and other towns were refused the same privileges for a long while.

In 1786 the governor, council and assembly passed an act providing that the justices of the general sessions of the peace for the several counties of the province should annually appoint, out of every town or parish in the same, overseers, clerk, constables, clerks of markets, assessors, surveyors, weighers of hay, fence-viewers. It will be seen from this and other acts that the divisions for local purposes consisted of counties, townships and parishes. In 1786, an act was passed for the better ascertaining and confirming of the boundaries of the several counties within the province, and for subdividing them into towns or parishes "for the more convenient and orderly distribution of the respective inhabitants, to enable them, in their respective districts, to fulfil the several duties incumbent on them, and for the better administration of justice therein."

Town and *parish* appear to have been always synonymous terms in this province. In the interpretation clause of a recent act, "parish" is defined as "*parish*, incorporated town or city."[2] This designation of one of the civil divisions of New Brunswick is, no doubt, so much evidence of the desire of the early settlers, many of whom were from Virginia and Maryland,[3] to introduce the institutions of their old homes. In all of the British colonies, indeed, the town system had long been in use. In the first instance, the

[1] Murdoch, iii. 42.

[2] N.B. Cons. Stat., c. 100, s. i.

[3] Among the members of the first council of New Brunswick, 1784, were Chief Justice Ludlow, formerly a judge of the supreme court of New York; Judge Israel Allen, of Pennsylvania; Gabriel G. Ludlow, of Maryland; Judge John Saunders, of Virginia. Not a few Virginia Loyalists settled in New Brunswick. Murdoch, iii. 42.

colonists introduced the local institutions of the parent state, with such modifications as were suitable to the conditions of their existence. But the "parish" of the colonies, as a rule, bore little resemblance to the historic "parish" of England. The latter was simply the old township of the Saxons in an ecclesiastical form: "the district assigned to a church or priest; to whom its ecclesiastical dues and generally also its tithes are paid. The boundaries of the parish and the township or townships with which it coincides, are generally the same; in small parishes the idea and even name of township is frequently, at the present day, sunk in that of the parish; and all the business that is not manorial is despatched in vestry meetings, which are however primarily meetings of the township for church purposes."[1]

Throughout New England the township was the political unit. It is true that the religious convictions of the people dominated in all their arrangements for the administration of civil affairs. An eminent authority has said of the people of Massachusetts: "They founded a civil state upon a basis which should support the worship of God according to their conscientious convictions of duty; and an ecclesiastical state combined with it, which should sustain and be in harmony with the civil government, excluding what was antagonistic to the welfare of either."[2] In England the parish was invested with civil functions, and the old Saxon township became gradually absorbed in former. But in New England the parish and township had really distinct meanings. Whenever the word "parish" was there used, it was to denote the township from an ecclesiastical point of view, as well as a portion of township not possessing town rights. Consequently the "parish of Massachusetts" was essentially a term used for religious purposes, and had no reference to civil matters which were all discharged in the township or political unit of the community.[3] In Virginia, however, the parish attained considerable prominence in the administration of local affairs. The early settlers of the old Dominion were men wedded to the ancient institutions of the parent state, and they set up the system long established in England, with such changes as were adapted to the circumstances of the country. Parishes were originally coterminous with the old plantations or with the counties, and covered immense areas. In the course of time, when the country became more settled, counties were laid out and divided into parishes. Some of these parishes sent representatives to the house of burgesses in early times of the colony, and they were always important local units in the civil organisation of the country. It does not, however, appear that they ever possessed powers entirely equal to those enjoyed in the parent state.[4] No doubt the loyalists who settled in New Brunswick and other sections of British North America were so accustomed to this division that they naturally introduced it when they came to organise the new province. We have already seen, in our sketch of local government in Upper Canada, that there was an effort made to establish parishes in that section. It is only in New Brunswick, however, that the name has become permanently inscribed on the civil organisation of the country. I do not of course refer in this connection to French Canada, where the division was constituted purely for ecclesiastical purposes, and had no relation to the English parish which is the descendant of the

[1] Stubbs, Const. Hist., i. 85.

[2] Parker's Lowell Institute Lectures, p. 403.

[3] The English Parish in America; Local Institutions in Virginia, by E. Ingle. p. 52.

[4] Local Institutions, etc., pp. 52, 53.

township of early English times—itself developed from the mark communities of the Teutonic tribes.[1]

The Island of Prince Edward, originally known as St. John's, formed part of the province of Nova Scotia until 1769, when it was created a separate province, with a lieutenant-governor, a combined executive and legislative council, and in 1773 a legislative assembly of eighteen members.[2] The history of this island is interesting from the fact that it gives an instance of a land system which kept the province in a state of agitation for many years, until it was finally settled soon after the union with the Dominion. The island was surveyed by Captain Holland in 1765, and in 1767 divided into sixty-seven townships, containing in the aggregate 1,360,600 acres.[3] This extensive tract was conveyed by ballot with some reservations, to officers and other individuals who had claims or supposed claims on the crown, and a landed monopoly was in this way established in the island. The grantees were to settle in the province or establish a certain number of settlers within ten years, but these proper conditions were practically laid aside and an absentee ownership allowed to grow up, to the great injury of the tenants who farmed the lands. In those days the crown availed itself lavishly of its prerogatives with very little regard to future settlement on the public lands of the country over which it exercised dominion. Previous to the arrangement just mentioned, a British nobleman had applied to the king for a grant of the whole island. His proposition was to divide it into hundreds[4] as in England, or baronies as in Ireland. These hundreds or baronies were to be divided into manors over which would preside a court baron, in accordance with the old English system. Townships were to be carved out of hundreds; courts leet and courts baron were also to be established under the direction of the lord paramount. A local historian has clearly epitomised the whole proposition as follows: "There was to be a lord paramount of the whole island, forty capital lords of forty hundreds, four hundred lords of manors, and eight hundred freeholders. For assurance of the said tenures, eight hundred thousand acres were to be set apart for establishments for trade and commerce in the most suitable parts of the island, including one county town, forty market towns, and four hundred villages."

[1] "Primarily the parish is merely the old township in its ecclesiastical aspect. We can, therefore, trace the descent of the modern civil parish through the ecclesiastical parish, up to the old Saxon township. It may be safely said that the English parish is the legitimate descendant of the Teutonic mark, and that the English parish, the New England township, the French or Belgian commune, and the village community of Northern India, are but variations of one common type which reproduces itself wherever the Aryan race is found. Whether the Teutonic mark system was ever introduced into England by our Saxon forefathers is an open question, but the Saxon township owed many of its distinguishing characteristics to the mark system. The township was so called from the *tun* or hedge which surrounded the group of homesteads." Chalmers' Local Government in England, p. 36.

[2] Bourinot, p. 69. See also copy of commission of the first lieutenant-governor, Captain W. Paterson. Canada Sessional Papers, 1883, No. 70, p. 2.

[3] Campbell's History, pp. 3, 19. Colonial Office List, 1885, p. 38.

[4] It does not appear that "hundreds" were ever established in Canada. The union of a number of townships for the purpose of judicial administration, peace and defence, formed what is known as the *hundred* or *wapentake*, in Anglo-Saxon times. "It is very probable," writes Stubbs (i. 96, 97) "that the colonists of Britain arranged themselves in hundreds of warriors; it is not probable that the country was carved into equal districts. The only conclusion that seems reasonable is that, under the name of geographical hundreds, we have the variously sized *pagi* or districts in which the hundred warriors settled." The first civil divisions of the infant settlement of Maryland were called "hundreds," and the election district of "Bay Hundred" on the eastern shore of the state, is a memorial of those old times. Local Institutions of Maryland, by L. W. Wilhelm, p. 39. A similar division was also known in the early history of Virginia. Ingle, pp. 40-47.

Each hundred or barony was to consist of somewhat less than eight square miles, and the lord of each was bound to erect and maintain forever a castle or blockhouse as the capital seat of his property, and as a place of retreat and rendezvous for the settlers; and thus, on any alarm of sudden danger, every inhabitant might have a place of security within four miles of his habitation. A cannon fired at one of the castles would be heard at the next, and thus the firing would proceed in regular order from castle to castle, and be "the means," adds the noble memorialist, "of putting every inhabitant of the whole island under arms and in motion in the space of one quarter of an hour."[1]

But this proposition was not entertained by the king, who had had some experience of a similar plan which failed in Carolina.[2] The division, however, of the whole island, among a few proprietors, appears to have had consequences probably fully as disastrous as would have been the concession to a single nobleman, who might have taken a deep interest in its settlement, as was notably done by Lord Baltimore in Maryland.

The island was originally laid out in counties,[3] parishes and townships. The county lines appear to have been run from north to south across the island at two of its widest parts. Where the boundaries of townships or parishes touch the county lines, they are coterminous therewith. The same is true of the township and parish lines. The average area of the townships is 20,000 acres, though number 66, the last regular township surveyed, contains only 6,000, and number 67, an irregular block in the centre of the island, is somewhat larger than the average.

Each parish includes from three to six townships. In addition to the territorial divisions before mentioned, there was laid out in each county, at the time of the original survey, a site for a *chef lieu*, or county town. For Queen's County, a town plot was laid out on the site of the present city of Charlottetown, at the head of Hillsboro' Bay, where the North-West and Hillsboro' Rivers unite. The town of King's County was laid out at Georgetown, on the south-east coast, on Cardigan Bay, and, for Prince County, a town site was surveyed on the east side of Richmond or Malpeque Bay, near its mouth. To each of these town sites there were attached distinct areas of land called "commons"[4] and "royalties,"[5] which covered about 6,000 acres each, and were not included in any of the townships. Instead of being reserved for their original purpose, the common and royalty attached to each town site were subsequently sold by the crown as farm lands, and are

[1] Campbell's History, ch. i. p. 11.

[2] Shaftesbury and Locke attempted to frame a constitution for Carolina, which would "connect political power with hereditary wealth." Bancroft's History of the United States, ii. 146.

[3] "In 1768 the Island was divided into three counties:—(1.) King's, containing 20 townships, 412,100 acres; county town, Georgetown, 4,000 acres (Les Trois Rivières). (2.) Queen's, 23 townships, 486,600 acres; county town, Charlottetown, 7,300 acres (Port la Joie). (3.) Prince County, 23 townships, 467,000 acres; county town, Princetown, 4,000 acres (Malpeque)." Murdoch's History, ii. 474. The names in parentheses are those of the old French settlements.

[4] These common lands were a memorial of Anglo-Saxon times. "The pleasant green commons or squares which occur in the midst of towns and cities in England and the United States most probably originated from the coalescence of adjacent mark-communities, whereby the border-land used in common by all was brought into the centre of the new aggregate.... In old towns of New England.... the little park.... was once the common pasture of the town." Fiske's American Political Ideas, pp. 39, 40.

[5] "In its primary and natural sense, 'royalties' is merely the English translation or equivalent of *regalitates, jura regalia, jura regia.*" See an interesting definition of the term given by the judicial committee of the privy council, Legal News (Montreal), vi. 244; and Bourinot, p. 690.

now occupied and cultivated as such, though the city of Charlottetown extends beyond the old town site, and covers a portion of the common. The county town of Prince County was not established at Princetown, but at a point on the shores of Bedeque Bay, on the south coast, now called "Summerside."

As we have just seen, there was an attempt made in Prince Edward Island to establish parishes as in other parts of the old colonies, but, in the course of time, these local divisions became practically useless, and are seldom mentioned now, except in legal proceedings connected with old land titles. It is only in Prince Edward Island, I may add, that we come across the term "royalties" as reservations of the crown, in the vicinity of the old settlements. In the other provinces, however, provision was made for the establishment of commons,[1] though, in the course of time, they, too, in the majority of cases, were leased for private purposes and ceased to become available for the general use of the community. The legislature of Nova Scotia, for instance, passed an act in 1816 to lease twenty-five acres of the Halifax common, in half acre lots, for 999 years.[2]

In this island, the several divisions to which we have referred appear to have been established chiefly for representative and judicial purposes. No system of local government ever existed in the counties and parishes, as in other parts of America. The legislature has been always a municipal council for the whole island.

VI.—The Establishment of Municipal Institutions in the Provinces of the Dominion.

We have now brought this review of local government up to the time when a new era in the history of political institutions commenced in all the provinces of British North America. The troubles which culminated in the Rebellion of 1837-8 led to the reunion of the Canadas and the concession of a more liberal system of government to the people. The British authorities recognised the necessity of leaving the people free to control their own internal affairs, and of giving up that system of paternal government which had worked so unsatisfactorily. Between 1840 and 1854 all the provinces were granted responsible government in the real sense of the term, and entered almost immediately on a career of political and national progress which was in remarkable contrast with the condition of things previous to 1840. The legislation of the province was distinguished by greater vigour as soon as the people obtained full control of their own taxation and revenue. The result was the improvement of the communications of the country and the passage of measures in the direction of increasing the responsibilities of the people in the management of their local affairs.

In the speech with which Lord Sydenham, then governor-general, opened the legislature of 1841, he called attention to the fact that it was "highly desirable that the principles of local self-government, which already prevail to some extent throughout that part of the province which was formerly Upper Canada, should receive a more extended application and that the people should exercise a greater control over their own local affairs."[3] The

[1] Nova Scotia Archives, Aikins, p. 700.
[2] Murdoch, iii. 415.
[3] Assembly Journals, 1841, p. 8.

legislature accordingly went energetically to work to provide for the internal government of the upper province. Some difficulties arose in dealing with this question on account of the position taken by Lower Canada. During the suspension of the constitution in French Canada, an ordinance had been passed by the special council "to provide for the better internal government of this province by the establishment of local or municipal institutions therein." The province was divided into twenty-two districts, comprising certain seigniories, townships, and parishes. The governor and council fixed and determined the number of councillors who were elected for every district. The warden was appointed by the governor-general, and his duties were regulated by instructions from the same high functionary. The meetings of householders, at which the parish or township officers as well as the district councillors were elected and other business was transacted, were convened on the authorisation of the warden by one of the justices of the peace for the district. The governor had the power to dissolve a district council under extraordinary circumstances. Instructions were issued by the governor and council to the chairmen of parish or township meetings, assessors, collectors, surveyors of highways and bridges, overseers of the poor, and other local officers. [1]

Consequently, the system in operation in Lower Canada was entirely controlled by the government. It was the desire of the Upper Canadians, who had been gradually educated for more popular local institutions, to elect the warden and other officers. The measure which was presented in 1841, by Mr. Harrison, provincial secretary of the upper province, provided that the inhabitants of each district should be a body corporate within the limits prescribed by the act, and provision was made for the formation of municipal councils, to consist of a warden and a fixed number of councillors in each district. Power was given to these councils to assess and collect from the inhabitants such moneys as might be necessary for local purposes, and generally to adopt measures for the good government of the respective districts represented in these local bodies. The Upper Canadians naturally wished to elect their own warden, but it was argued that it was inexpedient to concede to one province privileges not given to the other. The French members in the legislature were not only opposed to the measure passed by the special council, but believed that, if they sanctioned the passage of a liberal measure in Upper Canada, it would be followed by similar legislation for Lower Canada. The most influential men in that province were opposed at that time to any system that might impose local direct taxation on the people. [2]

Imperfect as was the act of 1841, it was the commencement of a new era in municipal government in Canada. In the course of a few years the act was amended, and the people at last obtained full control of the election of their own municipal officers. Statutes passed from time to time swept away those numerous corporate bodies which had been established by the legislature of the old province, and provided by one general law "for the erection of municipal corporations and the establishment of police regulations in and for the several counties, cities, towns, townships and villages in Upper Canada." [3] Lower Canada was also brought into the general system, according as the people began to comprehend the advantages of controlling their local affairs. The ordinance of the

[1] Canada Sessional Papers, 1841, App. X.

[2] Dent's Canada since the Union of 1841, i. 146.

[3] Con. Stat. 12 Vict. c. 80, and 12 Vict. c. 81.

special council was repealed in 1845 by an act, which provided that every township or parish should constitute a municipal corporation, represented by a council elected by the people, and presided over by a president or mayor, also elective.[1] This parish organisation seemed peculiarly well adapted to the habits of the people of French Canada, where the parish is connected with their dearest and most interesting associations; but for some reason or other it was soon changed to a county government, which lasted for a number of years.[2] Without, however, dwelling on the numerous acts which occupied considerable time in the legislature for years with the object of maturing and perfecting a general municipal system acceptable to the people and commensurate with their progress in self-government, it is sufficient to say that some time before 1867, when the provinces were confederated, Upper and Lower Canada enjoyed at last local institutions resting on an essentially popular basis, and giving every possible facility for carrying out desirable public improvements in the municipal divisions. The tendency of legislation indeed for years took a dangerous direction. Acts were passed, in 1853 and subsequent years, enabling the municipalities to borrow money for the construction of railways on the guarantee of the province.[3] The result was much extravagance in the public expenditures and the increase of local taxation in many municipalities of Canada, which hampered the people for many years, notwithstanding the benefits derived from the construction of important public works, until the government was forced to come to their assistance and relieve them of the burdens they had imposed upon themselves.

At the present time, all the provinces of the Dominion of Canada enjoy a system of local self-government which enables the people in every local division, whether it be a village, town, township, parish, city, or county, to manage their own internal affairs in accordance with the liberal provisions of the various statutory enactments which are the result of the wisdom of the various legislatures of the different provinces within half a century. It is in the great province of Ontario that we find the system in its complete form. While this system is quite symmetrical in its arrangement, it is also thoroughly practical, and rests upon the free action of the ratepayers in each municipality. The whole organisation comprises :—

(1.) The minor municipal corporations, consisting of townships, being rural districts of an area of eight or ten square miles, with a population of from 3000 to 6000.

(2.) Villages with a population of over 750.

(3.) Towns with a population of over 2000. Such of these as are comprised within a larger district termed a "county," constitute

(4.) The county municipality, which is under the government of a council composed of the heads of the different minor municipal divisions in such counties as have already been constituted in the province.

(5.) Cities are established from the growth of towns when their population exceeds 15,000, and their municipal jurisdiction is akin to that of counties and towns combined. The functions of each municipality are commensurate with their respective localities.[4]

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[1] Turcotte, Canada sous l'Union, ii. 24.

[2] In 1855 Mr. Drummond, then attorney-general, brought in a bill restoring the parish municipality, while preserving the county organization. Turcotte, ii. 260.

[3] Turcotte, ii. 202. See Consol, Stat. 22 Vict. c. 83.

[4] Canadian Economics; Montreal Meeting of the British Association, 1884, p. 317.

The council of every county consists of the reeves and deputy reeves of the townships and villages within the county, and one of the reeves or deputy reeve shall be the warden. The council of every city consists of the mayor, and three aldermen for every ward. The council of every town consists of the mayor and of three councillors for every ward where there are less than five wards, and of two for each ward where there are five or more wards. The council of every incorporated village and of every township consists of one reeve (who presides) and of four councillors. The persons elected must be natural-born or naturalised subjects of the Queen, reside within the municipality, and be possessed of a certain legal or equitable freehold or leasehold varying from $400 in townships to $1,500 in cities for freehold, and from $800 to $3,000 for leasehold. The electors must be ratepayers in the municipality. Every election must be held in the municipality to which the same relates. The election is by ballot, and complete provision is made for the trial of controverted elections and the prevention of corrupt practices. The municipal officers comprise a warden, mayor or reeve, clerk, treasurer, assessors, collectors, auditors, valuators. The mayors, reeves, aldermen and councillors are elected by the taxpayers, but the warden and all the other municipal officers are appointed by the councils. The powers of these bodies are exercised by by-law,[1] when not otherwise authorised or provided for. Certain by-laws require the assent of the ratepayers. The councils have the power to pass such laws creating debts and levying rates under certain restrictions set forth in the statute: for the purchase of property; for the appointment of municipal officers; for the aid of agricultural and other societies, manufacturing establishments, road companies, indigent persons and charities; for taking a census; with respect to drainage, the purchase of wet lands, the planting of ornamental trees, driving on roads and bridges, the seizure of bread or other articles of light weight, or short measurement; for the security of wharves and docks and the regulation of harbours; for the laying out and improvement of cemeteries, the prevention of cruelty to animals; for the purchase of property required for the erection of public schools thereon; and providing for the establishment and support of public schools according to law; for the regulation of fences; for the preservation of the public peace and morals; for the licensing of ferries; for the establishment of markets, fire companies, sewerage and drainage; for the aid of railways, by taking stock or granting a loan or bonus to the same.[2] These municipal bodies can be restrained in Ontario, as indeed in other provinces, by the superior courts when their by-laws are in excess of their powers. The courts may also compel them to exercise their power in proper cases. The provincial legislature grants the municipal authorities certain powers, and at the same time commits the proper exercise of those powers to the controlling care of the courts.[3]

The council of every municipal district in Ontario has now the power to make such material improvements as are necessary for the convenience and comfort of the people; but, more than that, the whole municipal organisation has been satisfactorily adapted to the requirements of a national system of education. On the enterprise and liberality of

[1] This legal term is a historic link that binds our municipal system to the old English township. In the shires of England where the Danes acquired a firm foothold the township was often called "by"; it had the power of enacting its own "by-laws," or town laws, as municipal corporations have generally to-day. Fiske's American Political Ideas, p. 46.

[2] Revised Statutes of Ontario, c. 174.

[3] O'Sullivan's Manual of Government, p. 191.

the municipalities depends the efficiency of the educational system of the province. The wealthy communities are able to erect school houses, which are so many evidences of their deep interest in public education and of the progress of architectural taste in the country. The legislature has also given power to any incorporated city, town or village to establish free libraries whenever a majority of the taxpayers express themselves in favour of such institutions.[1] In Ontario, as a rule, municipalities have taken advantage of the admirable opportunities which the law gives them of promoting the welfare and happiness of all classes, which are so intimately connected with the education and culture of the people. The city of Toronto, indeed, immediately availed itself of the law providing for free libraries, and has set an example which it is to be hoped will be followed by other communities in Canada.

In all the other provinces the municipal system, if not quite so symmetrical as that of Ontario, is based on the same principles. In the province of Quebec the municipal divisions consist of villages, towns, parishes, or townships and counties. The parish is necessarily recognised in the general law provided for the municipal organisation of the province. When a canonical parish has been once formed by the proper ecclesiastical authority,[2] it may at any time be erected into a municipality by civil authority. Although the law makes a general provision for the civil erection of a parish, it is also frequently found expedient to avoid the expense of the necessary proceedings by obtaining special powers from the legislature for erecting and confirming a parish for all civil purposes.[3] The county council is composed of the mayors of the several local municipalities of the county in which those officials have been elected. The councillors elect one of their number to be mayor of the local municipality, while the warden is chosen by the county council. The principal officers are the secretary-treasurer, who receives and pays out taxes and other moneys in accordance with law, auditors, inspectors of roads and bridges, pound-keepers, and valuators. The cities and towns of the province are, however, incorporated by special acts, and their mayors as well as councils are elected by the people.

In the provinces of New Brunswick and Nova Scotia, the people were more laggard in adopting a municipal system than in Upper Canada. Nova Scotia had for years a permissive act on its statute book, by which any county might be incorporated when the people made formal application to the governor-in-council in the manner provided. It was not, however, until 1879 that an act[4] was passed providing for the incorporation of the whole province. The county councils now consist of a warden and councillors. The council elect a warden from among themselves, a clerk, treasurer, auditors, assessors, pound-keepers and overseers of highways. All the powers and authorities previously vested in the grand jury and sessions, in special sessions, or in justices of the peace, to make by-laws, impose rates or assessments, and appoint township or county officers, are now exercised by the various municipal councils in the province. The money annually voted for road and bridge service is now appropriated by the councils of the municipalities under the inspection of supervisors or commissioners.[5] Cities and towns are incorporated by special acts, and the mayors and wardens are elected by the inhabit-

[1] Ont. Stats., 45 Vict. c. 22.

[2] See before, p. 55, note.

[3] For example, Quebec Stat., 45 Vict. c. 41.

[4] Nova Scotia Stat., 42 Vict. c. i.

[5] N. S. Stat., 44 Vict. c. i., and by 45 Vict. c. i. and 46 Vict. c. i.

ants duly qualified by law.[1] In New Brunswick a similar municipal system has been for years in operation.[2]

The little province of Prince Edward Island, however, has never established a complete municipal system; the legislature is practically the governing body in all matters of local improvement. It passes acts establishing and regulating markets, and making provision for the relief of the poor, for court houses, jails, salaries, fire department, ferries, roads and bridges, and various other services which, in the more advanced provinces, are under the control of local corporations. Every session the house resolves itself into a committee of the whole, to consider all matters relating to the public roads, and to pass resolutions appropriating moneys for this purpose, in conformity with a certain scale arranged for the different townships.[3] Charlottetown and Summerside have special acts of incorporation. Provision, however, was made some years ago for the establishment of certain municipal authorities in towns and villages of the island. Wardens may be elected by the ratepayers of a town or village, to perform certain municipal duties of a very limited character.[4]

In British Columbia, Manitoba, and the Northwest Territories very liberal provision exists for the establishment of muncipal corporations on the basis of those that exist in Ontario.[5]

VII.—Conclusion.

I have attempted in the preceding pages to trace, step by step, the various stages in the development of that system of local self-government which lies at the foundation of the political institutions of the provinces of the Dominion. We have seen that progress in this direction was very slow until the people increased in wealth and political knowledge, and were granted a larger measure of liberty in the administration of provincial affairs. We look in vain during the days of the French Regime for anything approaching those free institutions which are the natural heritage of an Anglo-Saxon people. Under the invigorating inspiration of those political representative institutions, which followed the supremacy of England in Canada, the French Canadians, like all other classes of the population, learned, at last, to appreciate the advantages of being permitted to manage their own local affairs. It is noteworthy, however, that we do not find anything approaching the town system of New England during the early times of British North America. Those primary assemblies of Massachusetts, which were so many representatives of the folkmoot of early English times,[6] were never reproduced among the

[1] See act incorporating town of Sydney, 48 Vict. c. 87. It is not easy to understand why the municipal heads of towns in this province should be called "wardens." A distinction should certainly be made between the warden of the county and the heads of the other municipalities. It is confusing, to say the least.

[2] Revised Statutes of New Brunswick, c. 99.

[3] Assembly Journals, 1884, p. 222.

[4] P. E. I. Stat., 33 Vict. c. 20.

[5] See Brit. Col. Stat., c. 129; Man. Stat., 46 and 47 Vict. c. 1; Ordinances of N. W. T., No. 2, 1885. In the Northwest Territory, the heads of the councils, outside of cities and towns, are designated "chairmen." Elsewhere these officers are known as "mayors." In Manitoba, the old titles of "reeve" and "mayor" are preserved in the municipalities.

[6] "A New England town meeting is essentially the same thing as the folk-mote." E. A. Freeman, American Institutional History, p. 16.

people that settled the provinces. Indeed, the conditions under which those countries were peopled were antagonistic to the establishment of the town organisations of New England. The British government, after its experience of the old Thirteen Colonies, decided to guide the affairs of their remaining possessions with the hand of a gentle despotism, and did not permit the formation of institutions which might weaken the allegiance of the people to the crown. It was however a mistaken idea, as it was clearly pointed out in Lord Durham's Report, to have discouraged the establishment, at an early period, of a municipal system in Canada, which would have educated the people in self-government, and made them more capable of grappling with the difficulties of the representative institutions granted them in 1791. However, the genius of an English race for managing their own affairs rose superior to the influence of a paternal government many thousand miles distant, and won, at last, for the people of Canada, a complete municipal system, which may well be the envy of the British people, who are now endeavouring to extricate themselves from the chaos of local laws, which make local government in the parent state so unintelligible to the ordinary citizen.[1] All sections and peoples of the Dominion are equally favoured in this respect. Throwing aside the traditions of a race unfamiliar in early times with the institutions of the Teutonic peoples, the French Canadians have also been brought into the van of municipal progress, and enabled to promote many measures of local necessity, which, otherwise, they could not have accomplished.

In a paper of a strictly historic scope, it would be out of place to dwell at any length on the merits and demerits of the institutions which now prevail throughout the Dominion. It is only necessary to say that we should not conceal from ourselves the fact that there is always danger in a system which hands practically to the few the control of the affairs of the many—which, in a measure, encourages the tendency of the majority to shift responsibility on to others, and, consequently, gives constant opportunities to the corrupt and unscrupulous demagogue to manage the municipal affairs of a community in a manner most detrimental to the public interests. Indifference to municipal affairs on the part of those who should have the greatest stake in their careful, economical management, is an ever present peril under a system like ours. The abstention of the educated and wealthy classes from participation in local affairs, is a growing evil which, in some communities in the United States, has led to gross extravagance, corruption and mismanagement. No doubt, if it were possible to resort to the folkmoot of the old times of our ancestors, or to their best modern exemplar, the township meetings of New England, and permit the people to assemble and consult together on their local affairs, a public advanvantage would be gained; but, unfortunately, such assemblages seem only possible in primitive times, when population is sparsely diffused, and large cities and towns are the exception.[2] The rapid increase of population, and the numerous demands of our complex

[1] "English local government can only be called a system on the *lucus non lucendo* principle. There is neither coördination nor subordination among the numerical authorities which regulate our local affairs. Each authority appears to be unacquainted with the existence, or, at least, with the work of the others. 'There is no labyrinth so intricate,' says Mr. Goschen, 'as the chaos of our local laws.' Local government in this country may be fitly described as consisting of a chaos of areas, a chaos of authorities, and a chaos of rates." Chalmers' Local Government in England, p. 15. No wonder then that English statesmen have at last awoke to the necessity of grappling with a problem which Canada herself has in a great measure solved.

[2] Since the remarks in the text were penned, I have had an opportunity of reading a paper on the Town and City Government of New Haven by C. H. Swetmore, Ph. D., in which the impracticability of the old town system

civilisation, have forced on us a municipal system which must be representative in its character—which must entrust to a chosen few the management of the affairs of the whole community. The dangers of the system are obvious to all, and should be carefully borne in mind by the intelligent and sagacious leaders and thinkers of every community. Happily, as the peril is apparent, so the remedy is always open to the majority. The security of our local institutions rests on the vigilance of an outspoken press, on the watchfulness of the superior legislative bodies, and on the frequency of elections, during which the people have abundant opportunity of criticising and investigating the administration of municipal affairs. On the whole, then, it would be difficult to devise and mature a system better calculated to develop a spirit of self-reliance and enterprise in a community, or to educate the people in the administration of public affairs. It is not too much to say that the municipal bodies of this country are so many schools where men may gain a valuable experience, which will make them more useful, should they at any time win a place in that larger field of action which the legislature offers to the ambitious Canadian.

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of New England under modern conditions is clearly proved. In New Haven, there is a dual system of town and city government. The annual town meeting, the ancient general court for the town (the folkmoot of all the voters resident in the Republic of New Haven), is still periodically held for the election of town's officers, authorising and estimating expenditures, and determining the annual town tax for 75,000 people. The author cited says (p. 69):—"This most venerable institution in the community appears to-day in the guise of a gathering of a few citizens, who do the work of as many thousands. Only the few understand the subjects which are under discussion. But citizens of all parties and of all grades of respectability ignore the town-meeting and school-meeting alike. Not one-seventieth part of the citizens of the town has attended an annual town-meeting; they hardly know when it is held." The proposal to abolish this dual system where it exists in New England, and substitute a simple administration, is now familiar to every one. The old system, in fact, has outlived its usefulness.

III.—*Historical Record of the St. Maurice Forges, the Oldest Active Blast-Furnace on the Continent of America.* *By* F. C. WURTELE, Librarian of the Quebec Literary and Historical Society.

(Communicated by Dr. George Stewart, May 26, 1886.)

The St. Maurice Forges are situated on the River St. Maurice, about nine miles north-west of the town of Three Rivers, in the county of St. Maurice, province of Quebec. The establishment of the post of Trois Rivières was made in the year 1617, because it was found desirable by the French authorities at Quebec to have a central trading port on the St. Lawrence, midway between Quebec and Montreal. It is on record that in 1617 Champlain and Father Joseph sailed for France, after sending Father Jean d'Olbeau and Brother Pacifique Duplessis to the post of Trois Rivières. "Metaberoutin" was the Indian name for the River St. Maurice, and when the French navigators arrived at its mouth they found three large channels formed by two extensive islands, and exclaimed, "Voilà, trois rivières;" thus, from that circumstance, the post was named "Trois Rivières," or "Three Rivers."

Many narratives and historical facts are found in the "Relations des Jesuites," and in old French manuscripts, from which the following brief account is taken of a trip made in 1635 from Quebec to Trois Rivières, by Buteux and Paul le Jeune, Jesuit Fathers of the Mission de la Conception:—"On September 8th, 1635, we arrived at Trois Rivières. It is an agreeable place of residence; the soil is sandy, and at certain seasons the fishing is very lucrative. An Indian would occasionally bring back several sturgeons in his canoe, the smallest of which would be six feet in length. There is also a large quantity of other kinds of excellent fish. The French have called this place 'Trois Rivières,' because a very fine river here falls into the St. Lawrence by three different channels. This division is caused by several small islands, which stop the outlet of this river, which is called by the Indians *Metaberoutin.* The country between Quebec and this new settlement, which I shall in future call 'La Résidence de la Conception,' appeared to me to be very pleasantly situated; it is drained by a number of rivers and small streams which flow at intervals of distance into the St. Lawrence, that king of rivers, which, even at thirty leagues from Quebec, is two to three thousand yards wide."

Jacques Buteux and Jean de Quen resided at Trois Rivières, in 1641, when de Champfleur was governor of that place.

Colbert, the prime minister of Louis XIV, sought to discover some new means of increasing the prosperity of New France, and was particularly anxious to discover iron ore, which, from information he had received, was very abundant. In August, 1666, he sent Sieur de la Tesserie to Bay St. Paul, where he discovered an iron mine which appeared to be rich. In 1665, de Courcelles was appointed governor, and Talon, the intendant of New France. The latter, in 1667, by Colbert's orders, caused some explorations to be made, and on his return to France in 1668, he succeeded in obtaining the sanction of

Colbert for new mining explorations, and Sieur de la Potardière was sent to Canada for that purpose. On his arrival at Quebec he was shown specimens of iron ore brought from Champlain and Cap de la Madelaine, by order of Daniel de Remi, Seignieur de Courcelles. One sample was mixed with sand and the other was massive. La Potardière visited the mines near Trois Rivières, and strange to say, reported that they offered nothing advantageous, either in quality or quantity. The result of this unfavorable report was that nothing was attempted towards their development for many years.

Dr. Michel Sarrasin, in his "Mémoires," makes the following reference to these mines :—"The discovery of the mineral on the banks of the St. Maurice dated from 1667, but the establishment was not conducted with skill or judgment until 1736." And in another paragraph says : "The establishment made about the year 1733, by order of the King, for working the iron mines on the St. Maurice, about nine miles above Cap de la Madelaine, was always called 'Les Forges' or 'Le Village des Forges.'"

Baron Maseres, in a book published in London, in 1772, says, that the first deed which appears in connection with the Forges, is the original concession of the seigniory of St. Maurice to Dame Jeanne Jalope (Jallaut, according to Abbé Tanguay), widow of Maurice Poulin, Sieur de la Fontaine, king's attorney for Trois Rivières. The seigniory was given to her and her children and their heirs in consideration of a letter from Talon, the intendant, that in which he promised, if Poulin would do certain things, he would give him a deed. The date of the concession is August 14th, 1676, and is signed at Trois Rivières, by Ducheneau, the lieutenant-governor. It states that she is to have the right to work all mines, etc., and it appears that she could not sign her name.

Louis de Buade, Comte de Frontenac, succeeded de Courcelles as governor of New France, in 1672. In referring to the original manuscripts relating to his administration, some allusion to the St. Maurice iron mines is occasionally found, showing that they were then considered valuable. The following is an extract from a letter of Comte de Frontenac to the French government, dated November 2nd, 1672 :—"The iron mine, of which I have already spoken, is of great consequence. I have visited it myself, in order that I may be enabled to give a more accurate account of its nature. I am gratified to learn that another mine has been discovered in Champlain, which is much richer than the Cap de la Madelaine mine, and the ore is in greater abundance. I apprehend that it will be next to impossible to exhaust this mine, as there is an extent of country of four leagues in length, from Cap de la Madelaine to Champlain, which is covered with iron ore ; all the streams indicate its existence. I had the curiosity to taste the water, and I found it all strongly impregnated with rust and iron ore, but the miners whom I sent there establish the fact beyond doubt. They are now working there, and if you have any intention of establishing forges and a foundry, you may be certain that the material will not be wanting. There are six piles of ore now lying at Cap de la Madelaine, which, according to the annexed report of the miner, would last for two castings a day for four months. The important question is the placing of the forges. For my part, I should prefer building them on Ruisseau Pepin, which is in Champlain, rather than at the Cape, where the Jesuit Fathers have a mill already in operation. By thus placing the forges, they would be between the two mines, and the material could be more easily conveyed from both to the central establishment. When you have decided upon establishing the said forges, as the workmen you will send out will be competent men, they, perhaps, can decide better whether there is enough water

in the stream I have above mentioned, to work the wheels of the projected forges, and can also judge whether it would not be practicable to bring the other streams in the neighborhood, such as Ruisseau d'Hertel, to increase the quantity of water. The chief miner, who is here, assures me that this can be easily and successfully done. It is certain that if these forges are once established, many advantages will result to the colony: excellent iron will be manufactured there, and the consumption of fuel will help materially in the clearing of the forest land. Moreover, many men will be employed at the works, and a market will thus be afforded for the surplus provisions which we have at our disposal."

There appears to have been a deed of donation of the seigniory, on January 19th, 1683, from Dame Jeanne Jalope to her son Michel Poulin, in which he also undertakes certain obligations towards his brothers and sisters. And on April 30th, 1683, there is a discharge from Jean Baptiste Poulin de Courval, one of the brothers.

In 1681, the Marquis de Denonville thus writes to the French Government:—" I am convinced that there is a very fine iron mine in the vicinity of Trois Rivières, where a forge could be profitably worked. I wish I had a man here who could plan the construction of an establishment of that kind; it would be of great use to his Majesty the King and the whole colony. M. Vallon can inform you, my lord, how M. de Colbert has tested the quality of the ore, and with favorable results. I have sent a small quantity to M. Arnoul, who can give you an account of it. There is a large stream in the vicinity of the mine." The French Government were evidently unwilling to act on the suggestions of their officials in Canada on the subject of iron mines; for five years later de Denonville again sent a despatch, dated November 18th, 1686, as follows:—" I have this year again had the iron mine near Trois Rivières thoroughly examined. I am convinced that there is a much larger quantity of that metal than the colony requires. The great desideratum is the discovery of a stream or water-power which can be used in winter, and with a view to this, we require an able, experienced man who could see what could be done for the establishment. Last year I sent a sample of this iron to France, and the iron-workers, who found it of good quality and percentage, wish to have fifteen or twenty barrels to give it a thorough trial as to quality: it would be well to satisfy them on this point next year. If our Northern Company should succeed, there would be no difficulty in accomplishing this desirable object." On November 28th, 1690, there is a deed of discharge from François le Maistre de la Morille, who married Mdlle. Poulin, the sister. Pierre Poulin a son of Michel Poulin, on April 4th, 1725, made *acte de foi et hommage*, the feudal acknowledgment of his tenure, to the governor at the Castle of St. Louis, in Quebec, for himself and his brothers, for the fief and seigniory of St. Maurice.

On April 5th, 1725, *l'aveu et denombrement*, the acknowledgment and survey, or census, of the seigniory was made. The King does not seem to have granted the mining rights along with the land, for he gave a license to work the mines, to Francheville, on March 22nd, 1730.

A company was formed on January 16th, 1733, consisting of Francheville, Peter Poulin, Gamelin, and Cugnet, for working the mines, and forges seem to have been put up; but Francheville died, and the enterprise having proved unsuccessful, his widow, with Poulin, Gamelin and Cugnet, on October 23rd, 1735, surrendered the forges and the rights of working the mines to the Crown.

On October 15th, 1736, Peter Poulin, Louise de Boulanger, his wife, and his brother, Michel Poulin, a priest, sold the fief and seigniory of St. Maurice, which was necessary for working the mines, to a new company, composed of François Etienne Cugnet, Pierre François Taschereau, Olivier de Vezain, Jacques Simonet and Ignace Gamelin, for 6,000 livres, with no terms, so long as they paid them 300 livres a year.

The King, by an order in council on April 22nd, 1737, empowered the above partnership, called Cugnet and Company, or "La Compagnie des Forges," to work the forges, and advanced them the sum of 100,000 livres, claiming no rent or dues of any kind. As the original grant of land to the widow Poulin, in 1676, viz., one league frontage on River St. Maurice by two leagues inland, was not now deemed sufficient, Hocquart, the intendant, on September 12th, 1737, conceded to Cugnet and Company the fief of St. Etienne, because they represented themselves as being in want of wood, and that if they were forced to buy it from the *habitants*, or farmers, they would have to pay ruinous prices for it. This is the first time that the forges were properly worked, and in 1739, a skilled artisan was brought from France, who possessed a knowledge of the different branches of manufacturing wrought and cast iron, combined with a competent skill in working mines. Some few years later, in 1740, Cugnet and Company, having exhausted their capital in erecting furnaces, smelting houses, workshops and other buildings, were forced to return their charter to the "Gouvernement de Trois Rivières," and on May 1st, 1743, the King ordered the forges to be reunited to the royal domain, and an attempt was made with some success to carry on the works on account of, and in the name of, the King. Skilled workmen came from France, who repaired the furnaces and built the walloon hearth, which has been in use ever since and is still visible.

Prof. Peter Kalm, in his travels through New France, stopped at Trois Rivières on August 3rd, 1749, and visited the Forges, fully describing them in his "Travels into North America," published in London, in 1771. He remarked that "there are here many officers and overseers, who have very good houses built on purpose for them. It is agreed on all hands, that the revenues of the iron works do not pay the expenses which the king must every year be at in maintaining them. They lay the fault on the bad state of population, and say that the few inhabitants in the country have enough to do with agriculture, and that it, therefore, costs great trouble and large sums to get a sufficient number of workmen. But however plausible this may appear, it is yet surprising that the king should be a loser in carrying on this work, for the ore is easily broken, very near the iron works and very fusible. The iron is good and can be very conveniently dispersed over the country. These are, moreover, the only iron works in the country, from which everybody must supply himself with iron tools, and what other iron he wants. But the officers and servants belonging to the iron works appear to be in very affluent circumstances."

Bigot was appointed intendant at Quebec, in 1748. In 1752 he recommended Franquet, who had been sent from France as royal inspector of fortifications, to visit the St. Maurice Forges, which he did, and gave an interesting account in a manuscript, still extant, of his reception at the "big house," or "La Grande Maison des Forges," and of the working of the concern. The following is an extract:—"M. Bigot, intendant of New France, who resides at Quebec, had recommended me to visit the St. Maurice Forges, as the establishment was extensive, and as he had no doubt that I should be pleased to be in a position to give an account of it. By stopping at Trois Rivières, I

could reach the forges in two hours; so having settled upon that course, I requested M. Rigaud, who was then in charge of that post, to accompany me. We left Trois Rivières at 5 o'clock in the morning with M. de Tonnancour, and other friends, whom M. Rouville, director of the forges, had invited to accompany us. On leaving the town we ascended a hill covered with sand, crossed a plain and passed through a wood of stunted trees, on emerging from which, we stood on a hill overlooking the valley in which the said forges of the king are situated. We crossed a wooden bridge over a small stream, and disembarked from our conveyance at the door of the director's dwelling. After the first ceremony of reception by the director, his wife and the other *employées*, we proceeded to visit the works. The stream, which drives the machinery, is dammed up in three places; the first dam drives the wheel for the furnace, the second and third, each a trip hammer. Each dam has a water pass to prevent overflow in high water; it is supposed that the stream or water-power is sufficiently strong to drive two more hammers. The buildings of the post are irregularly situated on the banks of the stream, and little or no taste seems to have been displayed in placing them. The principal building is the director's residence, a very large establishment, but scarcely large enough for the number of workmen who have to be accommodated.[1] On entering the smelting forge, I was received with a customary ceremony. The workmen moulded a pig of iron, about fifteen feet long, for my special benefit. The process is very simple: it is done by plunging a large ladle into the liquid, boiling ore, and emptying the material into a gutter made in the sand. After this ceremony, I was shown the process of stove moulding, which seems a simple though an intricate operation; each stove is in six pieces, which are separately moulded; they are fitted into each other, and form a stove about three feet high. I then visited the shed where the workmen were moulding pots, kettles and other hollow ware. On leaving this part of the forge, we were taken to the hammer forge where bar iron of every kind is hammered out. In each department of the forges, the workmen observed the old ceremony of brushing a stranger's boots; in return they expect some money to buy liquor to drink to the visitor's health. This establishment is very extensive, employing upwards of 180 men. Nothing is consumed in the furnaces but charcoal, which is made in the immediate vicinity of the post. The ore is rich, good and tolerably clean; formerly it was found on the spot, now the director has to send some distance for it. The management of these forges is economical. It must be readily understood, that, owing to the numerous branches in which expenditure must be incurred, unless a competent man be at the head of affairs, many abuses would be the consequence. Among other *employés*, his Majesty the King supports a Recollet father at this establishment, with the title of *aumonier*. This iron is preferred to the Spanish iron, and is sold off at the king's store, in Quebec, at the rate of from twenty-five to thirty *castors* (beaver skins) per hundredweight. In order to obtain a better knowledge of the position of these works, I would refer to the notes sent to the court of France, on this subject, wherein will be found all details of their management. I may say, however, in conclusion, that they are unprofitable to the King, and I am assured that if they were offered on lease at public sale, 100 pistoles per annum might be procured for them. After a splendid dinner at M. de Rouville's mansion, we returned to Trois Rivières, highly pleased with our visit,

[1] The "big house," or the "grande maison des forges," as it is called, was still inhabited in 1863.

and took supper at M. de Tonnancour's. The distance from town to the forges is nine miles."

The notes referred to by Franquet, addressed to the French court, contain little of sufficient interest to require translation. He dwells upon the nature of the management, the necessity of greater economy, the advisability of sending out competent operatives and furnace men from France, and lays down, in general terms, a plan for the successful working of the mines. We have reason to believe that many of his suggestions were acted upon by the French government, as a marked improvement was effected in the manufacture of iron work at the forges from 1752 to 1759.

These extracts are from the only reliable authorities on the subject in early Canadian history, and clearly establish the discovery of iron ore, and subsequent working of the St. Maurice Forges, until the year 1752, within a very short time of the conquest of French Canada by the English.

On September 13th, 1759, the battle of the Plains of Abraham was won by General Wolfe, and Quebec subsequently capitulated. The war was carried on for a year longer before the whole of Canada was ceded to England. The articles of capitulation between Lord Amherst, commander-in-chief of his Majesty's troops in North America, and the Marquis de Vaudreuil, governor and lieutenant of the king of France in Canada, were signed at Montreal on September 8th, 1760.

In Article 44 of these capitulations the following clause occurs :—" The papers of the intendancy, of the officers of the comptroller of the marine, of the ancient and new treasurers of the King's magazines, of the officers of revenues and Forges of St. Maurice, shall remain in the power of M. Bigot, the intendant, and they shall be embarked for France in the same vessel with him. These papers shall not be examined."

Thus the St. Maurice Forges, and all pertaining thereto, became the property of George III, king of England. The *employés* were kept on, and the forges were worked under the direction of the military authorities for five years, when they were transferred to the civil government of Trois Rivières. The following letters narrate the management of the forges during what is termed the "Military reign" in Canada, and prove that General Amherst lost no time in getting the works in operation under the new regime.

" Lettres et Placards afflichés dans la gouvernement des Trois Rivières, 1760 à 1764, durant la régne militaire.

"Ordres à Monsieur Courval, inspecteur aux Forges, pour la régie des Forges, 1er Octobre, 1760.

" MONSIEUR :—Son excellence, M. le Colonel Burton, m'a ordonné, de vous faire sçavoir, qu'en consequence des instructions qu'il à reçu de Monsieur le General Amherst, il juge à propos de faire exploiter a loisir la fonte qui est déjà tirée des mines, et pour cette effet voudroit retenir sur le même pied que ci-devant les ouvriers dont vous trouverez les noms à la suite de la presente. Le charbon étant un article indispensable, et dont les forges sont actuellement mal pourvues, et son excellence ayant appris qu'il y en a plusieurs fourneaux déjà preparés ; il vous plaira d'engager en qualité de journaliers les charbonniers et autres que vous jugerez absolument necessaires pour faire la cuisson et autre ouvrages dependants de cette partie là. Vous tiendrez, s'il vous plait, une compte exacte des gens que vouz emploirez, du temps que durera leurs travaux, et de quantité de charbon qu'ils feront. Vous

prendrez sur vous les soin de faire graisser et relever les soufflets des forges, en un mot, de faire les petites reparations qui sont absolument nécessaire pour mettre les forges en état d'exploiter peu à peu la fonte dont il est parlé ci-dessus.

" J'ai l'honneur d'être, Monsieur, &c., &c.

" J. BRUYÈRE."

Bruyère was evidently acting as secretary to Colonel Burton. Colonel Haldimand was military governor of Trois Rivières, and also commandant of the troops on that station from April 25th, 1762 to July 6th, 1765, and all of his letters and documents are now in the Dominion Archives office at Ottawa, being called the "Haldimand collection" of manuscripts, from which the following extracts are taken.

In 1762, the lords of the board of trade and plantation in London, requiring information on the resources of Canada, forwarded a series of questions to General Murray, who returned the replies, dated May 31st, 1763, called "Report of General Murray on Quebec." Question No. 16 (B. 7, page 78, in the Haldimand collection), "What number of forges in this Province, what iron made, in what form and quantity?" was answered from Trois Rivières by Colonel R. Burton:—

" The only forges in this government are those of St. Maurice, seven or eight miles behind the town of Trois Rivières, up the river of that name. That establishment consists of one furnace and two forges, built upon a rivulet, whose water never freezes; it discharges itself into the River St. Maurice, from whence the iron may be easily conveyed in *batteaux* to magazines at Trois Rivières, and from thence in vessels to Montreal, Quebec or Europe. There are besides a large stone house for the manager, and wooden houses for the people employed at the forges or other necessary works. The mine that has hitherto supplied the forges, lies very near the surface of the earth, in a low, marshy ground, seven or eight miles from them. There has hitherto been no road made to it, as they used to fetch the ore in winter upon sledges, but a good one may be easily made. The iron made from this ore is so excellent in quality, that in a late trial made by order of his Excellency General Amherst, it was found greatly superior to any made in America, and even exceeds that imported from Sweden. The mine was opened in 1732, and granted in 1736 to a company. They having no bottom, and wanting economy, were obliged to abandon it in 1741. The King, who had advanced them a sum of money, and could not be paid, took the grant back, and ever since 1742 the forges have been worked for the benefit of the king under the direction of the intendants. The mine has produced ore in such plenty, that in the year 1746 the single furnace returned 1,011,000 lbs. of cast iron, which produced 500,000 lbs. net weight of iron bars, besides a great quantity of stoves, pots, etc. Notwithstanding which, the great number of useless people kept there, such as a director, a comptroller, a treasurer, a contractor for the forges and provisions, several overseers, a chaplain and others, at large salaries; the little attention paid to the lands to procure oats and hay for the establishment, instead of buying it at a great distance and at a considerable price, with the connived fraud of those that passed the accounts, rendered that establishment rather burthensome than profitable to the crown, and the king was always proved debtor. From the beginning of the year 1761 to the latter end of the year 1762, not to engage in too large repairs, the forges, by order of his Excellency, Sir Jeffrey Amherst, have been worked on a small

scale, and have cost $11,325, for which they produced iron bars of different sizes to the weight of 285,400 lbs , besides 180 iron stoves. The ore, which has been run and worked, was already brought to the foot of the furnace. All the machinery, tools and buildings, that had been for some years past condemned by the French, as unfit for use or service, are now in a most ruinous condition, and cannot absolutely go on much longer without a thorough repair. But, however, the natural advantages still remain, viz., the mine itself, to which may be added another yet untouched, behind Cape Madelaine, lying about three miles from the forges on the other side of the River St. Maurice, the woods above the establishment, some clear lands to grow oats, lowlands that may easily be turned into meadows for hay, not granted yet, a quarry of limestone, absolutely necessary for the melting of ore, rebuilding or repairing the furnace, etc., eight miles up the River St. Maurice, navigable with a small *batteau*, and lastly the rivulet upon which two more forges and a furnace may be built without any incumbrance to each other. All these, if thought proper, may certainly be greatly improved to the advantage of the crown by supplying his Majesty's navy with proper iron for shipbuilding.

" At Trois Rivières, in Canada, the 31st day of May, 1763.

" R. BURTON."

The forges were also utilized for converting unserviceable ordnance into bar iron. The returns in 1762 showed a profit of $3,314, and the works were always carried on to advantage, but it was a troublesome undertaking, and not congenial to military men. General Gage was of opinion that it would be best for the Crown to lease them to intelligent, responsible parties, who would soon make a fortune.

The civil government of Canada was established August 12th, 1764, and General Gage wrote from New York on September 17th, following, to Colonel Haldimand, to settle the forge accounts and transfer them to the civil governor, Cramahé.

Under date of June 21st, 1765, Colonel Burton wrote from Montreal to Colonel Haldimand, as follows :—

" I have received a letter from General Gage, dated June 5th, acquainting me that, as the forges are now in the hands of the civil government, a regular account should be stated from the time they began to be under my care until they were delivered up to the civil governor, that, whatever balance there may be, it must be paid into the hands of the deputy paymaster-general, to be credited by them to the Crown."

The civil government did nothing with the forges, and they remained idle till 1767, when an enterprising Quebec merchant, named Christophe Pellissier, formed a company to resuscitate the works. A petition was, therefore, addressed, through his Excellency Guy Carleton, governor-in-chief of the colony, to George III, asking for a lease of the St. Maurice Forges to the company at a moderate rental. The petition was acceded to, and on June 9th, 1767, a proclamation was issued by the governor, granting the tract of land and works known as "Les Forges de St. Maurice," to Messrs. Christophe Pellissier, Alexandre Dumas, Thomas Dunn, Benjamin Price, Colin Drummond, Dumas St. Martin, George Allsop, James Johnston, and Brooke Watson, for the term of sixteen years, commencing on June 9th, 1767, and ending on the same day in the year 1783. The rent was fixed by this proclamation at the annual sum of £25, lawful money of the province of Quebec.

The company made repairs and erected buildings at a cost of £4,500, and turned out a great quantity of iron, strictly adhering to the French system of working in use before the Conquest; beyond this there is no reliable information about Pellissier and Company's management until the invasion of Canada by the Americans in 1775, when Trois Rivières seemed to be a sort of headquarters for the enemy, who were continually passing to and from Quebec, till their final overthrow at La Croix Migeon, near Pointe du Lac, by General Carleton, in 1776.

The following interesting and reliable information about the forges under Pellissier's management is taken from the "Mémoires de Laterrière," written by a young French gentleman, Pierre de Sales Laterrière, who having come from France in 1766, and been appointed agent at Quebec for the St. Maurice Forge Company in 1771, sold their manufactures at their store, situated in front of the lower town market, facing Notre Dame Church.

In February, 1775, he was appointed inspector of works, under the managing director, Christophe Pellissier, and resided at the forges, in the big house, with a competent salary and one-ninth interest in the company. His description of the works is as follows:—"On the banks of the Rivière Noir or St. Maurice, nine miles from Trois Rivières, one arrives at the forges, very pleasantly situated in a seigniory of twelve square miles, called the Fief St. Maurice. The country is flat, of a yellow sandy soil, containing many swamps and *brûlés*, where the iron ore is found. This ore contains sulphur and earthy matter, and yields about thirty-three per cent. of pure iron. The only fuel used is charcoal, that for the furnaces is made from hard wood, and for the refinery, from soft wood. There are from 400 to 800 persons employed in the woods, mines, quarries, workshops and offices of the Company, including the managing director, inspector, book-keeper, foreman, six furnace-men, two stokers, one caster, eight moulders, with as many assistants. At each forge there worked, besides six men, two stokers, four smiths, four carpenters, and sixteen laborers." The works employed eight boatmen, four prospectors of mines, forty carters, and others such as wood-cutters, charcoal burners, miners, road-makers, firemen, and eight men busied in the saw mills. For the convenience of the *employés* and their families, the company kept a store for the sale of provisions and other merchandise, and also did a considerable trade with the Tête de Boule Indians, who came down the River St. Maurice. Around the forges and big house, where the manager and his staff resided, quite a village of work-men's houses had sprung up, some 130 in number, neat and clean, with pretty gardens and *parterres*. The gross proceeds of the forges were from £10,000 to £15,000 in the working season or *campagne*, as it was called, of seven months, being about £50 per day each from the furnaces and foundry, and £50 per week from each forge. The working expenses consumed about two-thirds, leaving one-third to be annually divided among those interested. The works were carried on with energy and success, and yielded a good profit."

Owing to the incursions of the Americans mentioned before, Trois Rivières was a stirring place, but rather dangerous than pleasant to live in. General Montgomery passed here with his army to his fatal and unsuccessful attack on Quebec. Pellissier's loyalty to King George was of a very frail nature, and, from his sympathy with the enemy, he passed freely through their lines, and had an interview with Montgomery at his head-quarters at Holland House, near Quebec. He also materially assisted the Americans by furnishing them with stores, provisions, etc., to the extent of some £2,000. By his

orders shot and shell were cast at the forges, to be used at the bombardment of Quebec. Affairs went on thus till the retreat of the Americans began, and Trois Rivières was not clear of them till their complete defeat by General Carleton at the battle of Pointe du Lac on June 8th, 1776.

The inspector narrates that when the English fleet with Carleton's army on board arrived at Trois Rivières, the Americans or "Bostonnais", as they were called, retreated to Sorel; but a force of some 4,000 of them returned to attack Trois Rivières, conducted by a *habitant* from Machiche, named Larose, as far as Pointe du Lac. The English general was informed of their designs and took up a position at La Croix Migeon, on the heights commanding the town and its environs, where he waited their attack and completely routed them, killing a great many. The next day his Excellency ordered the inspector of the forges to send out all his hands to beat the woods, which they did, taking some 130 prisoners in a starving condition, fed them and turned them over to the English at Trois Rivières.

The night before the battle the manager, Pellissier, received a warning note from his friend the *grand vicaire*, St. Onge, which caused him at once to make off in his canoe to his friends "Les Bostonnais" at Sorel, not forgetting to take with him all the available funds of the forges, and also the bills or vouchers of the above mentioned advances, which he subsequently collected from the American Congress and sailed for France.

These losses considerably hampered the operations of the forges, but by hard work and inspector Laterrière's indomitable energy they soon were in as flourishing a condition as ever, and reached under his management in 1778 the zenith of success. An order now came from Pellissier to make up the accounts and close up his interest in the concern, which was completed in October, 1778, when Alexandre Dumas, in whose favor the transfer was made, took charge of the works and conducted the affairs of the company to the expiration of the lease on June 9th, 1783.

Governor Haldimand, by Royal proclamation, leased the forges and lands pertaining thereto to the Hon. B. Conrad A. Gugy, a member of the council, for a term of sixteen years, commencing on June 10th, 1783, on the same conditions as those imposed upon Pellissier and Company. The annual rental was fixed at the sum of £18 15s. 0d. sterling money of Great Britain.

In the beginning of the year 1787 Gugy got into financial difficulties, and on March 10th of that year his estate, together with the unexpired lease of the St. Maurice Forges, was sold by sheriff Gray of Montreal. The lease was adjudged to Messrs. Alexander Davison and John Lees, copartners, for the sum of £2,300 currency. Subsequently this partnership was dissolved, and Mr. Davison became sole proprietor of the unexpired lease.

On June 6th, 1793, Alexander Davison sold his rights and titles to the premises to George Davison, David Monro and Matthew Bell, copartners, for the sum of £1,500 currency. On March 20th, 1799, at the recommendation of Governor Prescott, the lease was extended to April 1st, 1801, at a rental of £18 15s. sterling per annum, in favor of the same parties. At the expiration of this lease, the governor, Sir Robert Shore Milne, by proclamation, leased the property to Messrs. Monro and Bell for a term of five years, to end in 1806, at a rental of £850 per annum. At its expiration the lease was extended for one year, when it was advertised in the "Quebec Gazette" to be sold by public auction on June 11th, 1806, the lease to count from April 1st, 1807. The necessary plans and surveys not being

completed, the sale was postponed, and readvertised on the same conditions for October 1st, when it took place, and was adjudged to Mr. Bell for £60 per annum for a term of twenty years, because the auctioneer had no instructions to put on it an upset price. Consequently the executive council refused to ratify the sale, as the difference between the former lease, £850, and £60 was too great. Therefore the same firm were permitted to hold the property in sufferance at the old rental, £850, till January 1st, 1810, when the governor, Sir James Henry Craig, leased the forges and lands attached thereto to the same firm of Monro and Bell for a term of twenty-one years, to end on March 31st, 1831, at an annual rental of £500 currency. It is said that the amount of profit realised from the date of their first occupation to 1806, exceeded that on their subsequent operations even at the reduced rental of £500 per annum. The cause is easily seen, when it is recorded that the governors of Canada revelled in the enjoyment of every luxury that the hospitality of Messrs. Monro and Bell could provide for them. The Tally-ho Hunt Club was an institution at the forges, and their shouts of "Tally-ho!" resounded through the hills and dales of the River St. Maurice, and the "brush" was competed for by well-mounted red-coated cavaliers, with as much energy and activity as in the mother land beyond the sea. These extravagances easily absorbed whatever profits the forges yielded,—and from their being the only manufacture of the kind in the country, the profits must have been enormous.

The lease was extended from year to year by orders-in-council till 1834, when a ten years' lease was granted to the same firm. It then came to the knowledge of the government that great dissatisfaction existed among the people of Three Rivers, and others, on account of the monopoly of such a great extent of land held by the lessees of the St. Maurice Forges in virtue of their lease. That the town of Three Rivers was shut in, and, moreover, the lands were required for settlement. Also, the trade of the town derived no advantages from the works, because the company imported all their supplies and sold all their manufactures through agents residing in the different cities of Canada. This was proved by a commission, appointed in 1836 by Government, to take evidence on certain things connected with the Jesuits' estates. Accordingly the Government ordered Mr. E. Parent to make a report on the forges. This was completed and sent in to the executive council, being dated September 15th, 1843, and approved by his Excellency the Governor-General on the 26th. It contained the recommendation "that Mr. Bell continue in occupation for one year beyond the present term, and then for reasons set forth, among others, that it would be more beneficial to the revenue, to the holders of the forges, to the people of Three Rivers, to the trade and manufactures of the province, that the forges be sold to the best advantage and to the highest bidder." Surveyor-General Thomas Parke was ordered to make a complete survey, and subdivide the tract into farm lots.

By order of Lord Metcalfe, the governor-general of Canada, on November 20th, 1845, a report from D. B. Papineau, commissioner of crown lands, was made, pointing out the disadvantages resulting from the system hitherto pursued, of letting out the Forges of St. Maurice and the lands adjoining, and recommending the immediate sale of the forges, on certain conditions; and the disposing of the lands after the *tenure en franc aleu roturier*, and *à rente foncière, rachetable* under certain conditions. An order-in-council, approving the recommendations contained in the above report was passed on November 22nd, 1845, and on December 19th the forges were advertised to be sold by public

auction on Tuesday, August 4th, 1846, at 11 o'clock, in the forenoon, at the court-house in Three Rivers. An order-in-council, of July 29th, fixed the upset price, at £3,000. The sale took place as ordered, and the forges were adjudged to Mr. Henry Stuart for £5,575, thirty bids, in all, having been given by Messrs. T. Hart, Henry Stuart, Matthew Bell, and Judah. Mr. Stuart offering to purchase the fiefs St. Etienne and St. Maurice, a report was made by the commissioner of crown lands, dated September 19th, 1846, recommending their sale to him for £4,500. But by order-in-council they were advertised to be sold by public auction on November 3rd, the upset price to be £4,500. The sale took place and the fiefs were adjudged to Mr. Henry Stuart, for £5,900 currency, according to the advertised conditions. Forty bids were given over the upset price, two by Mr. Hugh Cameron, and the rest by Messrs. George Pacaud and Henry Stuart, mostly of £25 each. Mr. Stuart commenced operations vigorously, and expended large sums of money in the latest improvements in machinery. He repaired the big house, increased the staff of workmen, and a French engineer induced him to invest more money on new works, which soon proved to be utterly useless.

So Mr. Stuart leased the place for a term of four years, on certain conditions, to the Hon. James Ferrier, of Montreal, from 1847 to 1851, who carried on the works with great success, owing to a strict system of economy in every department, proving that profits could be realised. In November, 1851, his term expired, and Messrs. Andrew Stuart and John Porter, of Quebec, purchased the forges and fiefs St. Etienne and St. Maurice from Henry Stuart, by assuming the payment of the balance of the purchase money owing to the Government.

Their occupation was not successful. The whole place seemed to have deteriorated. They tried to get concessions from the government on the terms of their purchase, but it seems without success. The forges fell into disuse, and the purchasers into arrears with the Government. The lands were nearly all squatted on by actual settlers, and in addition to this, the part of the lands bordering on the River St. Maurice was crossed by the booms of Mr. George Baptist. These gave rise to many difficulties, and the Crown, in order to solve them, determined to bring the property to sale, and, under cover of its mortgage, bought in the whole, when having protected Mr. Baptist's rights, it settled with the settlers by disposing of the lands as follows. The following is taken from report of Crown Lands for 1861, headed "The Crown Domain":—

"The Forges of St. Maurice, together with a number of lots in the township of St. Maurice, for which titles had not been issued by the original purchasers to the settlers, were seized in virtue of a judgment obtained by the court for non-payment of the balance of the purchase price of the property, and sold on the 22nd October. The forges not bringing the value set upon them by the Crown, were acquired by the latter for $7,200, and are now for sale. Nearly all the lands, most of which were squatted upon and improved, were also bought by the Crown to be disposed of to the settlers."

The following extract from the "Report of Crown Lands" for 1862, relates to the final disposal of the property by tender:—

"The Forges of St. Maurice, purchased by the department in 1861, at sheriff's sale, in the case of Regina *vs.* Stuart *et al.*, after due advertisement (by tender) were sold to Mr. Onesime Heroux, of St. Bernabé, for $7,000, of which he paid one-fourth cash, and the balance is exigible in three equal annual instalments with interest. The township of St.

Maurice (containing the fiefs of St. Etienne and St. Maurice), which the Crown acquired at the same time as the forges, under cover of its mortgage of *bailleur de fonds*, for the purpose of protecting the numerous squatters settled there, have since (with the exception of some half dozen of poor lots) been sold to the settlers at the price of 40 cents an acre, all of which has been received in cash, and the patents issued for the lots. The sale of these lots and that of the Forges was conducted by Mr. Judah, the officer in charge of the Domain branch of the Department, and not through the instrumentality of an agent, by which a saving of the usual commission to the latter, on the proceeds of sale, has been effected."

M. Heroux kept the farm attached to the forges, and sold to Messrs. John MacDougall and Sons, of Three Rivers, on April 27th, 1863, the forges proper, and water-powers, etc., for £1,700 currency. At the time of this sale the property was considered to have been exhausted, but the Messrs. MacDougall proved it to be the contrary; fuel and ore were procured as required, and the forges were worked by them for many years. The big house, built in the time of the French, was burnt down on the night of June 11th, 1863, after the MacDougalls' purchase, and was rebuilt by them on the original site. The old walloon hearth is still preserved.

The property was transferred to Mr. George MacDougall, on December, 18th 1876, and the forges were worked to the summer of 1883, when operations ceased; they have not been worked since, and are not likely to be put in blast again, because the ore and wood in the vicinity have been exhausted.

Iron ore was first discovered on this continent in 1607, near Jamestown, Virginia, and on April 10th, 1608, a ship loaded with it sailed for England. In 1620, skilled workmen arrived and works were established on Falling Creek, a tributary of the James River, about sixty-six miles above Jamestown; but misfortune seemed to follow the enterprise, for on March 22nd, 1622, the Indians made a raid on the settlement, massacred Mr. Berkeley, the manager, and all his men, and destroyed the iron works. No further attempt was made to make iron in Virginia for many years. Sixty years after iron ore was found in Virginia, the mines on the banks of the River St. Maurice were discovered. Furnaces and forges were erected in 1733, and from that time for 150 years they have been in active operation. This can be said of no other works of the kind on the continent of America. Thus the St. Maurice Forges hold an important and prominent position in the history of Canada.

IV.—*Brief Outlines of the most famous Journeys in and about Rupert's Land.*

By GEORGE BRYCE, LL.D., Manitoba College, Winnipeg.

(Read May 27, 1886.)

A.

Different Limits Assigned to Rupert's Land.

(1) Sir George Simpson, in his evidence before the committee of the Imperial Parliament, claimed that Rupert's Land extended from Hudson Bay to the Rocky Mountains.

(2) It was claimed by others that the western boundary of Rupert's Land was a line from Deer Lake south, about 102° 30′ W. longitude.

(3) Probably the most generally accepted definition of Rupert's Land, based upon the charter of the Hudson's Bay Company (1670), is the region whose waters flow into Hudson Bay, except so far as the old Province of Quebec entered this territory on its southern side.

The country lying to the west and north of Rupert's Land was divided into sections:—

(*a*) The territory drained by the rivers flowing into the Arctic Ocean, including therein the region of the Athabasca, Mackenzie and Coppermine Rivers.

(*b*) All the country lying on the west of the Rocky Mountains, between the Russian territory on the north and Columbia River on the south.

The wide expanse of country lying west and north of Rupert's Land was technically known as the "Indian Territories," and over this an exclusive fur-trading license was given to the Hudson's Bay Company by the Imperial Parliament, in 1821, for twenty-one years. This license was again renewed in 1838. The country lying to the west of the Rocky Mountains, reached by the Peace River, was, at times, called New Caledonia.

B.

Configuration of Rupert's Land and Indian Territories Favorable for Voyaging.

Two main arteries lead from Hudson Bay to the interior:—

(1) The most northerly of these is by way of Churchill River, at the mouth of which stood, in early days, Prince of Wales Fort, with massive stone walls and fortifications. Down this river, which was also called English River, the Hudson's Bay Company, for many years, received the trade of the interior without even leaving the coast, the

Indian tribes bringing their furs to the mouth of the river on the bay. By canoe and portage Lake Athabasca was reached by this route, which gave immediate communication with Mackenzie River to the Arctic Sea; with Great Slave Lake and Great Fish or Back River to the north-east; and with Peace River to the west. This last river afforded a pass through the Rocky Mountains to New Caledonia, flowing as it does through the Rockies from their western side, and connecting there by portages with the Fraser and Columbia Rivers of the Pacific slope.

(2) The second avenue to Rupert's Land was, by leaving Hudson Bay at York Factory, ascending Nelson River, and reaching Lake Winnipeg, which has three great tributaries: (1) Winnipeg River, which bears toward the lake the waters of Lake of the Woods, Rainy Lake and River, and other streams from a point within forty miles of Lake Superior; (2) Red River, which runs from the very sources of the Mississippi northward and receives the Assiniboine, one of whose tributaries, the Souris, approaches the Missouri at its head waters, and whose main body comes hundreds of miles from the western prairies; (3) the Saskatchewan, the "mighty rapid river" as its name implies, which drains, with its two branches, above the forks, a vast country, reaching to the Rocky Mountains. The wide region thus drained, consisting of the three geological areas—the Laurentian, the Prairie country, and the Rocky Mountain and Pacific slope—owing to its numberless lakes and interlacing rivers, afforded, even in its wild and unimproved condition, wonderful means of communication for the explorer.

C.

The Fur-Trading Companies Promoted, sometimes for their own purposes, and at times for the advancement of geographical knowledge, the Exploration of this Domain.

(1) The French fur-traders, to whom belongs the glory of exploring the Upper Lakes and the Mississippi, discovered, by way of Lake Superior, the Winnipeg River branch of this communication, and to them belongs the honour of finding, by this route, the Red, Assiniboine, Upper Missouri, and Saskatchewan Rivers, even to the Rocky Mountains.

(2) The original Hudson's Bay Company, leaving the sea, by the northern route and also by Nelson River, in 1774 established themselves on the Saskatchewan, and by the year 1800 held numerous points in Rupert's Land.

(3) The North-West Company of Montreal, which had, by its still independent traders, carried on trade from the Upper Lakes, even to Lake Athabasca, from the year 1766, became, in the year 1787, a strong company, so that, in a generation, its posts stretched from Montreal to Columbia River on the Pacific, and the men in its employ numbered five thousand.

(4) The X Y Company, or New North-West Company, to which belonged Sir Alexander Mackenzie and the Hon. Edward Ellice, was an offshoot of the North-West Company, and, beginning in 1796, it continued till 1804. It erected posts by the side of those of the North-West Company, so that, about the year 1800, there were points where a Hudson's Bay, a North-Wester, and an X Y Fort stood side by side.

(5) The Astor Fur Company of New York, begun in 1810, only lasted a few years,

but owing to the fort built by it, at the mouth of Columbia River, it did something of itself, and much more by the opposition it stirred up among the other companies, to encourage exploration.

(6) In 1821, by the union effected, there was but one fur company in Canada—the United Hudson's Bay Company. While at times following the policy of erecting a Chinese wall around its territory, yet, by the work of its officers, and by the facilities it afforded to great explorers, the Hudson's Bay Company has done much to increase the geographical knowledge of Rupert's Land and the regions beyond.

D.

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E.

Outlines of Famous Journeys.

(1) PIERRE GAUTHIER DE VARENNES, SIEUR DE LA VERANDRYE, was the son of the Governor of Three Rivers, in Quebec, and was born in the year 1685. He went home to France, entered the army, fought at the battle of Malplaquet, and was severely wounded

there. He returned to Canada invalided, with his rank of lieutenant, but this was not recognized in Canada. In consequence, the young lieutenant entered the fur trade, and found at Michilimackinac and in the Upper Lakes his field of labour. He was in charge of Fort Nepigon in 1728. Here La Verandrye heard of the interior, from Ochagach, a savage, who drew a map on birch bark, which was sent to the Governor, Beauharnois. Authority was given to La Verandrye and a Jesuit missionary, Gonor, to penetrate these little known regions, where no white man had trod. The following are the main points of the exploration:—

1731.—Aug. 26.—La Verandrye's party left Lake Superior, by way of Pigeon River, for the interior. In the same year the explorers reached Rainy Lake and built at its foot Fort St. Pierre, whose ruins are still visible.

1732.—The party discovered Rainy River and entered Lake of the Woods (*Lac des Bois*, also *Minitie*), and on its south-west shore built Fort St. Charles. Here, on Massacre Island, La Verandrye's son, a priest, and a number of the party were murdered by the Sioux.

1734.—By descending Winnipeg River, Lake Winnipeg (*Ouinipique*, "muddy water," Ojibway) was reached, and at the mouth of the river Fort Maurepas was built.

1735-6.—Crossing Lake Winnipeg, and entering Red River (*Miskouesipi*, "blood-red river," Ojib.) at the mouth of the Assiniboine River, called by La Verandrye "St. Charles," was built Fort Rouge, on the site of the present city of Winnipeg.

1738.—At some time before this year, at Pointe des Bois, some two hundred miles up Red River, above Fort Rouge, was built a fort. In this year, also, Fort de la Reine was erected on the site of the present town of Portage la Prairie.

1743.—La Verandrye's sons ascended the Assiniboine, left it to explore one of the tributaries, the Souris River, called by them "Rivière de St. Pierre" by portage from its head-waters to the Missouri, and up this river to the foot of the Rocky Mountains (*Montagnes de pierre*). After this, in the same year, La Verandrye returned to Quebec.

1743-8.—During these years were discovered Lakes Manitoba (*Manitowaban*, "Spirit's Straits"), Winnipegoosis ("Little Winnipeg"), and Dauphin, and Forts Dauphin and Bourbon were erected.

1748.—La Verandrye's son ascended the Saskatchewan ("Rapid River.")

1749.—La Verandrye was on the point of joining his sons to seek the sources of the Saskatchewan, when he died in Montreal, at the age of sixty-four. La Verandrye's sons now lost their license, and were succeeded by Legardeur de St. Pierre.

1752.—Fort Jonquière was built near the site of the present town of Calgary, on Bow River, near the Rocky Mountains by direction of St. Pierre.

1753.—Fort à la Corne was erected near the forks of the Saskatchewan.

1755.—Before this date, Fort Poskoiac had been erected in the same region.

1757.—Before this year, Fort des Prairies was built on the Saskatchewan.

(2) Joseph La France.

This adventurer was born at Michilimackinac, in 1704, a French half-breed. He had traded furs on the Upper Lakes and had visited Fort Frontenac. In 1738, La France, who was a species of free-booter, was seized by the governor and a party whom he chanced to meet on Nipissing River. Escaping from his captors, with his gun and only five charges of powder, the forest ranger reached Sault Ste. Marie—through two hundred miles of trackless wilderness. Having now lost everything, La France determined "to go to the English on Hudson Bay."

1740.—He followed La Verandrye's route down Rainy Lake and River (*du Pluis*)—then through Lake of the Woods (*Lac des Bois*, also *des Iles*), reached, by way of River Winnipeg, the Lake of the same name, and on its banks joined Cris or Christinaux (Cree) Indians, and tells of a flat country full of meadows on its shores.

1742.—Visited Lake Winnipegoosis with the Indians. Turned now towards the bay, and passing Lakes Du Siens and Cariboux, reached Pachegoia. This is the meeting place of the Indians who go down River Nelson to York Factory. April 4, one hundred canoes having been built from the birch trees which abound at Pachegoia, the furs were shipped and La France chosen captain of the expedition, which, June 29, arrived at York Factory. La France was the first man certainly known to have followed the "watery way" through the country from Lake Superior to Hudson Bay.

[Note.—It is well-known that the French Huguenot traders, Groselliers and Radisson, claimed to have discovered Hudson Bay, crossing through the country from Lake Superior to Hudson Bay, before 1670, the year in which the Hudson's Bay Company was formed. There is no certainty as to their expedition !]

(3) Samuel Hearne. ("The Mungo Park of Canada.")

The Hudson's Bay Company had for a hundred years clung to the coast. Their connections were with bands of Indians living in the interior, so far west as Athabasca and the Saskatchewan, who came with their furs every year to the sea coast. The North-West Company of Montreal was penetrating the country, whence their trade came, and they found it necessary to extend their explorations to the interior, and built posts at leading points. The man who took chief part in this inland enterprise was Samuel Hearne, an officer of the Hudson's Bay Company.

1769.—The explorer was provided with an escort, with astronomical and other instruments, and with instruments from Moses Norton, Governor of Prince of Wales Fort. His orders were, in passing through the country, to cultivate friendly rela-

tions with the several tribes, and "to smoke your calumet of peace with their leaders, in order to establish a friendship with them." He was to seek the Coppermine River. "If," say the instructions, "the said river be likely to be of any utility, take possession of it on behalf of the Hudson's Bay Company," by cutting your name on some of the rocks, and also the date of the year, month, etc.

Nov. 6.—Hearne set out from the mouth of Churchill River, with a salute of seven guns from Prince of Wales Fort, and, Dec. 11, after continual desertions of his men, and dastardly conduct on the part of his guides, arrived at the fort, having gone inland some two hundred miles.

1770.—Feb. 23, Hearne began a second voyage. On this expedition he reached a point five hundred miles inland, but his chief astronomical instrument was broken by an accident, and he returned to the coast in November.

On Dec. 7 of this year, the third voyage was undertaken, but this time with no firing of cannon. Making slow progress in winter, a rendezvous was reached by the explorer and several hundred Indians, and a dash made across the barren lands, and the Coppermine River reached.

1771.—July 18.—At this date, Hearne reached the mouth of the Coppermine, and looked out upon the Arctic Ocean—its discoverer. His scientific knowledge was so defective that he fixed the mouth of the Coppermine at 71° N. instead of 67° 48′.

1774.—Hearne built Fort Cumberland on the Saskatchewan.

(4) Sir Alexander Mackenzie.

Mackenzie was a young Scotchman, who came to Canada as a boy, entered the fur trade, and became a trader among the Nor'-Westers. At this date he was in pursuit of furs at Fort Chippewyan, on Lake Athabasca. His Company being rivals of the Hudson's Bay Company, he was stimulated by Hearne's discovery.

1789.—June.—He started with four canoes, manned by French Canadians and Indians. At the end of July, after stirring adventures with strange Indians, and annoyances from his own party, Mackenzie reached the Arctic Sea by way of the river bearing his name.

1791.—Mackenzie spent this year in Great Britain, having found, on his first voyage, the necessity for greater mathematical knowledge.

1792.—Oct.—Mackenzie left Fort Chippewyan, and started up Peace River to cross the Rocky Mountains, and reach the Western Sea. He wintered on Peace River, trading for furs, and experiencing the warm Chinook winds coming through the Peace River pass, thought the Western Sea very near.

1793.—In early spring the explorer went on his way, ascending Peace River. Upon July 22, the daring traveller, after almost unimaginable hardships, reached the Pacific Ocean, and inscribed on the face of a rock: "Alexander Mackenzie, from Canada by land, 22nd July, 1793." This was the first crossing of North America, north of Mexico, by the white man.

(5) *Three Great American Expeditions.*—The American Government, during the first quarter of this century, sent out three important expeditions, all connected with the settlement of the boundary line between the newly-acquired territory of Louisiana and the British possessions. The undefined territory of Louisiana was annexed to the United States in 1803.

I. Lewis and Clark.

The object of this expedition was to explore the Missouri country, and cross the Rocky Mountains to the Pacific Coast.

1804.—May 14.—Captains Lewis and Clarke, of the Army of the United States, with twenty or thirty soldiers and a dozen voyageurs, entered the mouth of the Missouri. By November, the expedition, having travelled some sixteen hundred miles, reached the country of the Mandans, who are dwellers underground, cultivate the soil, and make pottery. [A remnant still survives. They have been called the "white-bearded Sioux."] The explorers were here visited by British traders from Souris River.

1805.—Aug. 18.—The head waters of the Missouri, three thousand miles from the mouth, were reached. Horses were got, and after traversing for sixty miles through the mountains, a most difficult country, a navigable river, the Lewis, so called from the commander, was descended by canoes and the Columbia gained. They thus reached, on Nov. 15, the Pacific Ocean, by way of the Columbia River. Here they spent the winter in Fort Clatsop.

1806.—March 23.—The return journey was begun, one party ascending Clarke River. On Sept. 23, the reunited party arrived at St. Louis, fired a salute, and going on shore, received a most hearty and hospitable welcome from the "whole village."

II. Lieut. Zebulon M. Pike.

1805.—Aug. 9.—Lieut. Pike, of the U. S. Army, with twenty soldiers, left St. Louis to ascend the Mississippi to find its sources. Sept. 4, Prairie du Chien was reached. Oct. 1, the party left the Falls of St. Anthony.

1806.—Feb. 1.—The expedition had arrived at Otter Tail, Red Cedar, Red Lake, etc. "The country," says Pike, has the appearance of "an impenetrable morass or boundless savannah." On the 13th, the latitude of the source of the Mississippi was found to be 47° 42′ 40″. David Thompson, the astronomer of the North-West Company, had, in 1798, taken the same observation and made it 47° 38′. Lieut. Pike, having descended the Mississippi, arrived at St. Louis April 30.

[Note.—Lieut. Pike took part in the war between Canada and the United States, as Major Pike. He was, unfortunately, killed by the blowing up of a magazine at York, being struck in the breast by a heavy stone, April, 1813.]

III. Major S. H. Long.

1823.—It was determined by the American Government to explore St. Peter River, and "the country situated on the northern boundary of the United States, between the Red River of Hudson's Bay and Lake Superior."

On April 30 a party, under Major Long, with W. H. Keating, geologist and historiographer, left Philadelphia, passed through the country to Ohio, and thence went to Prairie du Chien on the Mississippi.

On July 6 they arrived at St. Anthony Falls, leaving Lake Travers, which the Indians call Otter Tail, on the 26th. This lake is one of the sources of the Mississippi and of Red River. On Aug. 8, the flag of the United States was hoisted on an oak post at Pembina, on the boundary line, 49° N. On the north side of the post were letters, G. B., and on the south, U. S.

The intention of the explorers had been to follow the boundary to Lake Superior, but dense swamps rendered this impossible.

On the 9th, the expedition left Pembina to descend Red River. They reached Fort Douglas, the centre of Selkirk Colony, and site of present city of Winnipeg, on the 11th, leaving on the 17th to descend Red River. On the 19th, Red River having been left behind, and Lake Winnipeg crossed, the party arrived at the mouth of Winnipeg River. On the 25th they gained the head of Winnipeg River. They crossed on the 28th the Lake of the Woods and entered the mouth of Rainy River, gaining Fort William, on Lake Superior, by Sept. 13, thus making eight hundred and twenty miles in twenty-seven days. The party left Sault Ste. Marie, Oct. 3; descended Lakes Huron, St. Clair and Erie; entered Erie Canal, and having reached Albany, proceeded homeward. The expedition reached Philadelphia on the 26th, having accomplished this marvellous voyage in less than six months.

(6) Sir John Franklin.

One of the first efforts to explore the country to the north of Rupert's Land was begun by Capt. John Franklin. He was accompanied by Dr. Richardson, surgeon of the Royal Navy, and Mr. George Back, both of whom afterwards commanded important expeditions.

1819.—May 23.—The party embarked in the Hudson's Bay Company ship "Prince of Wales" at Gravesend. Capt. Franklin, before leaving England, had conferred with Sir Alexander Mackenzie, the veteran explorer.

Aug. 30.—"Prince of Wales" arrived at York Factory.

1820.—Jan. 17.—Having come inland, the party reached Fort Cumberland, on the Saskatchewan, 690 miles from York.

On March 26, Dr. Richardson having remained at Cumberland House, Capt. Franklin and Back arrived at Fort Chippewyan, 857 miles from Cumberland. Dr. Richardson overtook the party here on July 13, and on the 18th the party left Fort Chippewyan for the Polar Sea. On Oct. 6 the party entered the winter quarters they had built, calling them "Fort Enterprise."

1821.—The expedition left Fort Enterprise June 14 to go to the Coppermine, and thence to the Polar Sea. They reached the mouth of the Coppermine July 18, and found it to be 67° 47′ 50″, thus correcting Hearne's mistake. On the 21st, the expedition started to coast the Arctic or Polar Sea to the east; and on Aug. 16, after a journey along a very indented coast of 555 geographical miles, for 6½°, reached Cape Turnagain. From this point, the expedition started back over barren grounds. They endured much suffering, living chiefly on "tripe de roche" (*Cladonis rangiferina*), and on Labrador tea (*Ledum palustre*), eating bits of burnt leather. Fort Enterprise was reached, but was desolate. Party wintered at Moose Deer Island.

1822.—May 26.—They left their wintering place, where five months had been spent. On the return journey Fort Chippewyan was left behind on June 5. The party arrived at Norway House July 4. Here the greater number of the men of the expedition were sent to Montreal, with orders on the Hudson's Bay Company for their payment. On the 14th, Capt. Franklin arrived at York Factory, and was received with much kindness by Governor Simpson and Mr. McTavish, representatives of the two companies—Hudson's Bay and North-West—which had united in the preceding year.

(7) Captains John Franklin and John Richardson. (*Second Overland Journey*, 1825-7.)

This journey was undertaken by Capt. Franklin. In his party were Dr. Richardson and Lieut. Back, his former companions, and Mr. Kendall. The object of the expedition was to explore the coast of the Polar Sea.

1825.—July 25.—The party left Fort Chippewyan to descend the Mackenzie River. They went into winter quarters in September at the fort they had built, called "Fort Franklin," at the entrance to the Great Bear Lake.

1826.—July 4.—*The party divides.* The western party, under Franklin, with Lieut. Back, left Point Separation in the "Lion" and "Release." They reached the mouth of the Mackenzie, and coasted up the western shore of the Polar Sea. Though desiring to reach the Icy Cape of Capt. Cook, in longitude 161° W., the party was not able to proceed further than "Return Reef," which it they gained on Aug. 17. On Sept. 21, they arrived at Fort Franklin.

July 4.—Richardson took command of the eastern party in boats "Dolphin" and "Union." On the 10th, they arrived at mouth of Mackenzie River, and on Aug. 8, by coasting the Polar Sea, they reached the mouth of the Coppermine. Having ascended the Coppermine River, or crossed Great Bear Lake, they arrived at Fort Franklin, before Franklin, on Sept. 1.

1827.—April 12.—Party arrived at Fort Chippewyan. On Sept. 29, Franklin and Richardson reached London.

(8) Capt. George Back.

In the year 1829, the well-known navigator, Sir John Ross, had gone, by ship, to seek the North-West passage. His absence for three years caused alarm. The British

Government, City of London, Royal Geographical Society, and many private subscribers contributed to send an expedition for the rescue of the gallant captain. The command was given to Capt. Back, who had accompanied Franklin on his first and second expeditions, of 1819 and 1825.

1833.—The expedition left England in February. The route taken was by New York, overland to Montreal, thence by voyageur's route up the Ottawa and the Upper Lakes, from Fort William to Lake Winnipeg, Norway House. Here another start was made up the Saskatchewan, to Portage La Loche, and the journey continued northward. On July 29, Fort Chippewyan, on Lake Athabasca, was reached. Here the real work of exploration began. The Indians discouraged the party greatly by their dismal account of the route.

Aug. 11, Back, with five men in his canoe, started for the Arctic Sea. He was followed by A. R. McLeod, an enterprising officer of the Hudson's Bay Company, with his men. The route was by way of the Great Fish River, going out of the eastern extremity of the Great Stone Lake.

1834.—The party spent this winter of 1833-4 in buildings they had erected, called "Fort Reliance." After many adventures, the estuary of the Fish or Back River was reached about latitude 68° N.

1835.—March 21.—Capt. Back began his return voyage and passed by way of Chippewyan homewards, reaching Norway House, June 24. He had, while in the far north, received letters telling him that Sir John Ross had returned safely in 1833 to Great Britain, having been rescued by the crew of a whaler.

(9) Thomas Simpson. (*Simpson and Dease's Explorations.*)

This expedition was undertaken by the Hudson's Bay Company, for the purpose of discovering the north-east coast of America. Dease was the senior officer, and had accompanied Franklin, though Thomas Simpson, a relative of Sir George Simpson, has received most notice.

1837.—On June 1, Simpson and Dease's party carried in two seaboats, named "Castor" and "Pollux," and a bateau called "Goliath," left Fort Chippewyan to descend the Mackenzie River. On July 6, the Arctic Ocean burst on the view of the expedition, and was saluted with joyous cheers. As they journeyed coasting the ocean, Return Reef was reached on the 23rd, and the party arrived at Boat Extreme on the 30th. On foot from Boat Extreme, Point Barron was visited Aug. 3, the western point which their instructions covered. They saw this point with emotion, 21° west of the mouth of Mackenzie River. On the 17th, they reëntered the mouth of the Mackenzie. By ascending the Mackenzie, and traversing Great Bear Lake, their winter quarters were gained Sept. 25. These they called "Fort Confidence."

1838.—June 6.—They started for Coppermine River, reaching its mouth July 2. On the 17th, they made a second sea voyage—now eastward from 115° W. On Aug. 25, they discovered new land, erected a stone pillar and unfurled the Union Jack

in the name of Great Britain. On Sept. 3, they reëntered Coppermine River. On the 14th, they arrived at Fort Confidence for winter.

1839.—June 15.—Descended the Coppermine, and in eighteen days emerged from its mouth. Aug. 20, reached furthest point east, Cape Britannia, 94° W., having been within one hundred miles of the Magnetic Pole, on Boothia Felix. Simpson and Dease explored the Arctic Coast for 40°—a marvellous result. On Sept. 24, they arrived at Fort Confidence again.

1840.—Feb. 2.—The party reached Fort Garry. June 30, Simpson desired to return to Arctic Sea, but, no instructions coming, started home, and on the 13th or 14th, was killed on prairies of Minnesota, either by half-breeds or by suicide. Body taken back to Red River settlement, and buried in St. John's Cemetery, Winnipeg.

(10) John Rae, M.D.

This expedition was to follow up the discoverers of Simpson and Dease, but by exploring the coast of Hudson Bay and reaching, if possible, the Cape Britannia of the aforesaid explorers.

1846.—June 13.—Dr. Rae, with ten men, started in two boats, the "North Pole" and "Magnet," from York Factory.

July 5, party left Fort Churchill. On Sept. 2, expedition wintered in house they had built, which was called "Fort Hope." This was on Repulse Bay.

1847.—April 19.—Reached Lord Mayor Bay, on the north side of Rae Isthmus, and on Gulf of Boothia, and erected a monument. In May they reached Fort Hope, and again sallied forth to coast the west shore of Melville Peninsula. A point was reached within ten miles of the Straits of Fury and Hecla. June 9, arrived at Fort Hope again. Aug. 12, Fort Hope left for return to York Factory. Sept. 6, party arrived at York Factory.

(11) Sir John Richardson. (*Overland Search for Sir John Franklin.*)

In 1845, Sir John Franklin, in the ships "Erebus" and "Terror," with a party of 130, had sailed away to seek the North-West passage. Two of the expeditions to search for the lost navigator were overland, or along the coast of Rupert's Land.

1848.—March 25.—Dr. Richardson, accompanied by Dr. Rae, left England. Not less than 180 tons of pemmican, made from beef in England, was shipped to Rupert's Land, by way of Hudson Bay, for the use of the expedition. The expedition proceeded by New York, Montreal, the Ottawa Canal route, the Upper Lakes, River and Lake Winnipeg, etc. July 11, Fort Chippewyan was reached. By Aug. 3, the mouth of the Mackenzie River, on the Arctic Sea, was gained.

During the autumn of this year, the party was not able to reach the mouth of the Coppermine, along the coast. Having gained Back's Inlet, the expedition made across the country for Coppermine River, reached it, and, ascending it, came to the house already erected, to which the name "Fort Confidence" had been given.

1849.—In the summer of this year, Dr. Rae descended the Coppermine, but found no traces of Franklin on the Arctic Coast. On Nov. 6, Dr. Richardson arrived in England.

[NOTE.—*The Successful Search for Sir John Franklin* was accomplished by two explorers. (1) On Aug. 15, 1853, Dr. Rae reached his old quarters, at Repulse Bay. March 31, 1854, he went on a spring journey. April 17, arrived at Pelly Bay. This bay lies to the west of Simpson peninsula. Here he got from the Eskimos the story that, in 1850, forty white men had proceeded south, and that, afterwards, their corpses had been found on the shore. He obtained from the Eskimo, telescopes, guns, watches, compasses, silver spoons and forks, with crests engraved, silver-headed walking stick, engraven with "Sir John Franklin, K.C.B.," Sir John's Hanoverian Order of Knighthood. Dr. Rae purchased a number of these. They had been obtained by the Eskimo by trade from the south. Dr. Rae arrived in England, claimed the reward, and obtained a portion of it. (2) The Final Settlement of the Question of Sir John's fate took place in 1859. Capt. McClintock, found a record left by the party, at Point Victory to the north-west of King William's Island. Sir John Franklin had died June 11, 1847. The ships, the "Terror" and "Erebus" were deserted April 22, 1848, having been beset since 1846.]

(12) VISCOUNT MILTON AND DR. CHEADLE.

This journey is usually called "The North-West Passage by Land." The book by Milton and Cheadle is charming in style.

1862.—July 18.—The explorers reached the Hudson's Bay Company port, Georgetown, in Minnesota, some 200 miles of the boundary, a memorial of the Company's original claim. From Georgetown, the party took canoes and descended Red River to Fort Garry. Aug. 23, much interested in the Red River settlement, they went west, over the prairies, with a brigade of carts. This was the typical mode of prairie travel. Sept. 26, the travellers determined to winter 550 miles north-west of Fort Garry. They built a winter camp, which they called "La Belle Prairie."

1863.—April 3.—The party left camp to proceed westward. Forts Pitt and Edmonton were passed. June 29, Jasper House was gained in the foothills of the Rocky Mountains. The party passed on through the Yellow Head (*Tête Jaune*) Pass. July 18, the explorers here ferried across the head-waters of Fraser River, near Tête Jaune Cache. Passing southward, Thompson River was reached. The road was here lost, and hardships, almost incredible, were endured, after which they arrived at Kamloops on the Thompson. After resting, the journey was resumed, the Fraser was reached, and Yale, and New Westminster and Victoria visited. Again ascending the Fraser, far up its course, the mines at Cariboo were explored. On Dec. 24, the party left Victoria, B.C., for Britain.

(13) SANDFORD FLEMING.

This journey belongs to the period of Confederation, rather than to that of Rupert's Land, and yet, in 1872, when it took place, Rupert's Land had hardly changed in any

respect. Principal Grant, as secretary of the expedition, well describes its progress. It differed in route from that of Milton and Cheadle, only in that it was conducted from "ocean to ocean" through Canadian Territory.

It may be said really to have begun at the mouth of the Kaministiquia, on Lake Superior. It followed the old canoe route by Rainy Lake and River, but left Lake of the Woods, not by Winnipeg River, but at the North-West angle, and thence proceeded to Fort Garry by the Dawson Road. The writer met the party at Fort Garry early in August, 1872.

The route from Fort Garry westward was that of Milton and Cheadle. On their returns journey the party left Esquimalt, in Vancouver Island, Oct. 14, to travel by way of the Pacific Coast steamer and Union Pacific Railway. This journey may be looked upon as the precursor of our Canadian Pacific Railway, though a more southerly route, and another pass has been followed by that great national line.

F.

Results Achieved.

1. La Verandrye and his immediate successors discovered and explored all the great rivers of the fertile portion of the Canadian Northwest.

2. La France first led the way from Lake Superior to Hudson Bay.

3. Hearne discovered the Coppermine River, the Arctic Sea, and was the Hudson's Bay Company's pathfinder to the interior.

4. Mackenzie discovered Mackenzie River, the Arctic Sea, and first crossed the Rocky Mountains to the Pacific Ocean, north of Mexico.

5. Pike discovered the sources of the Mississippi. Lewis and Clark gave ground for claims of country on Columbia River by the United States, explored the Missouri, and discovered rivers on the Pacific slope. Long established the boundary of 49° N., and made a remarkably rapid journey.

6. Franklin, Richardson, Back, Simpson, Dease and Rae may be said to have explored, outlined and named the whole coast of the Arctic ocean from Point Barron to Hudson Bay. Their names are all attached to rivers, straits or capes discovered by them. Their voyages are marvels of endurance and skill. Richardson and Rae were celebrated for their search for Franklin.

7. Milton and Cheadle accomplished their voyage with great tact, and their delightful book has been the *thesaurus* from which many of their successors have drawn.

8. Mr. Sandford Fleming's journey was the preliminary exploration for the Canadian Pacific Railway.

V.—*The Lost Atlantis.*

By DANIEL WILSON, LL.D., F.R.S.E., President of University College, Toronto.

(Read May 28, 1886.)

The legend of Atlantis, an island-continent lying in the Atlantic Ocean over against the pillars of Hercules, which, after long being the seat of a powerful empire, was engulphed in the sea, has been made the basis of many extravagant speculations. The story is recorded in the "Timæus" and, with many fanciful amplifications, in the "Critias" of Plato. According to the dialogues, as reproduced there, Critias repeats to Socrates a story told him by his grandfather, then an old man of ninety, when he himself was not more than ten years of age. According to this narrative, Solon visited the city of Sais, at the head of the Egyptian delta, and there learned from the priests of the ancient empire of Atlantis, and of its overthrow by a convulsion of nature. "No one," says Professor Jowett, in his critical edition of "The Dialogues of Plato," "knew better than Plato how to invent 'a noble lie';" and he, unhesitatingly, pronounces the whole narrative a fabrication. The world, like a child, has readily, and for the most part, unhesitatingly accepted the tale of the Island of Atlantis." But to the critical editor, this reception furnishes only an illustration of popular credulity, showing how the chance word of a poet or philosopher may give rise to endless historical or religious speculation. In the "Critias," the legendary tale is unquestionably expanded into details of no possible historical significance or genuine antiquity. But it is not without reason, that men like Humboldt have recognised in the original legend the possible vestige of a widely spread tradition of earliest times. In this respect, at any rate, I purpose here to review it.

It is to be noted that even in the time of Socrates, and indeed of the elder Critias, this Atlantis was referred to as the vague and inconsistent tradition of a remote past; though not more inconsistent than much else which the cultured Greeks were accustomed to receive. Mr. Hyde Clarke, in an "Examination of the Legend," printed in the Transactions of the Royal Historical Society, arrives at the conclusion that Atlantis was the name of the King, rather than of the Dominion. But king and kingdom have ever been liable to be referred to under a common designation. According to the account in the "Timæus," Atlantis was a continent lying over against the pillars of Hercules, greater in extent than Libya and Asia combined; the highway to other islands, and to a great ocean, of which the Mediterranean Sea was a mere harbour. But in the vagueness of all geographical knowledge in the days of Socrates and of Plato, this Atlantic domain is confused with some Iberian or western African power, which is stated to have been arrayed against Egypt, Hellas, and all the countries bordering on the Mediterranean Sea. The knowledge even of the western Mediterranean was then very imperfect; and, to the ancient Greek, the West was a region of vague mystery which sufficed for the localisation of all his

fondest imaginings. There, on the far horizon, Homer pictured the Elysian plain, where, under a serene sky, the favourites of Zeus enjoyed eternal felicity; Hesiod assigned the abode of departed heroes to the Happy Isles beyond the western waters that engirdled Europe; and Seneca foretold that that mysterious ocean would yet disclose an unknown world which it then kept concealed. To the ancients, Elysium ever lay beyond the setting sun; and the Hesperia of the Greeks, as their geographical knowledge increased, continued to recede before them into the unexplored west.

In the youth of all nations, the poet and historian are one; and, according to the tale of the elder Critias, the legend of Atlantis was derived from a poetic chronicle of Solon, whom he pronounced to have been one of the best of poets, as well as the wisest of men. The elements of oral tradition are aptly set forth in the dialogue which Plato puts into the mouth of Timæus of Locris, a Pythagorean philosopher. Solon is affirmed to have told the tale to his personal friend, Dropidas, the great grandfather of Critias, who repeated it to his son; and he, eighty years thereafter, in extreme old age, told it to his grandson, a boy of ten, whose narrative, reproduced in mature years, we are supposed to read in the dialogue of the "Timæus." Even these are but the later links in the traditionary catena. Solon himself visited Sais, a city of the Egyptian Delta, under the protection of the goddess, Neith or Athene. There, when in converse with the Egyptian priests, he learned, for the first time, rightly to appreciate how ignorant of antiquity he and his countrymen were. "O Solon, Solon," said an aged priest to him, "you Hellenes are ever young, and there is no old man who is a Hellene; there is no opinion or tradition of knowledge among you which is white with age." Solon had told them the mythical tales of Phoroneus and Niobe, and of Deucalion and Pyrrha, and had attempted to reckon the interval by generations since the great deluge. But the priest of Sais replied to this that such Hellenic annals were children's stories. Their memory went back but a little way, and recalled only the latest of the great convulsions of nature, by which revolutions in past ages had been wrought: "the memory of them is lost, because there was no written voice among you." And so the venerable priest undertook to tell him of the social life and condition of the primitive Athenians nine thousand years before. It is among the events of this older era that the overthrow of Atlantis is told—a story already "white with age" in the time of Socrates, three thousand four hundred years ago. The warriors of Athens, in that elder time, were a distinct caste; and when the vast power of Atlantis was marshalled against the Mediterranean nations, Athens bravely repelled the invader, and gave liberty to the nations whose safety had been imperilled; but in the convulsion that followed, in which the island-continent was engulphed in the ocean, the warrior race of Athens also perished.

The story, as it thus reaches us, is one of the vaguest of popular legends, and has been transmitted to modern times in the most obscure of all the writings of Plato. Nevertheless, there is nothing improbable in the idea that it rests on some historic basis, in which the tradition of the fall of an Iberian, or other aggressive power in the western Mediterranean, is mingled with other, and equally vague traditions of intercourse with a vast continent lying beyond the pillars of Hercules. Mr. Hyde Clarke, in his "Khita and Khita-Peruvian Epoch," draws attention to the ancient system of geography, alluded to by various early writers, and notably mentioned by Crates of Pergamos, B.C. 160, which treated of the Four Worlds. This, he connects with the statement, by Mr. George Smith, derived from

the cuneiform interpretations, that Agu, an ancient king of Babylonia, called himself "King of the Four Races." He also, assigns to it a relation with others, including its Inca equivalent of *Tavintinsuzu*, the Empire of the Four Quarters of the World. But the extravagance of regal titles has been the same in widely diverse ages; so that much caution is necessary before they can be made a safe basis for comprehensive generalisations. Four kings made war against five, in the vale of Siddim; and when Lot was despoiled and taken captive by Chederlaomer, King of Elam, Tidal, King of Nations, and other regal allies, Abraham, with no further aid than that of his trained servants, born in his house, three hundred and eighteen in all, smote their combined hosts, and recovered the captives and the spoil. Here, at least, it is obvious that "the King of Nations" was somewhat on a par with one of the six vassal kings who rowed King Edgar on the River Dee. Certainly, within any early period of authentic history, the conceptions of the known world were reduced within narrow bounds; and it would be a very comprehensive deduction from such slight premises as the legend supplies, to refer it to an age of accurate geographical knowledge in which the western hemisphere was known as one of four worlds, or continents. When the Scottish poet, Dunbar, wrote of America, twenty years after the voyage of Columbus, he only knew of it as "the new-found isle."

The opinion, universally favoured in the infancy of physical science, of the recurrence of convulsions of nature, whereby nations were revolutionised, and vast empires destroyed by fire, or engulphed in the ocean, revived with the theories of cataclysmic phenomena in the earlier speculations of modern geology; and has even now its advocates among writers who have given little heed to the concurrent opinion of later scientific authorities. Among the most zealous advocates of the idea of a submerged Atlantic continent, the seat of a civilisation older than that of Europe, or of the old East, was the late Abbé Brasseur de Bourbourg. As an indefatigable and enthusiastic investigator, he occupies a place in the history of American archæology somewhat akin to that of his fellow-countryman, M Boucher de Perthes, in relation to the palæontological disclosures of Europe. He had the undoubted merit of first drawing the attention of the learned world to the native transcripts of Maya records, the full value of which is only now being adequately recognised. His "Histoire des Nations Civilisées" aims at demonstrating from their religious myths and historical traditions the existence of a self-originated civilisation. In his subsequent "Quatre Letters sur le Mexique," the Abbé adopted, in the most literal form, the venerable legend of Atlantis, giving free rein to his imagination in some very fanciful speculations. He calls into being, "from the vasty deep," a submerged continent, or, rather, extension of the present America, stretching eastward, and including, as he deems probable, the Canary Islands, and other insular survivals of the imaginary Atlantis. Such speculations of unregulated zeal are unworthy of serious consideration. But it is not to be wondered at that the vague legend, so temptingly set forth in the "Timæus," should have kindled the imaginations of a class of theorists, who, like the enthusiastic Abbé, are restrained by no doubts suggested by scientific indications. So far from geology lending the slightest confirmation to the idea of an engulphed Atlantis, Professor Wyville Thomson has shown, in his "Depths of the Sea," that while oscillations of the land have considerably modified the boundaries of the Atlantic Ocean, the geological age of its basin dates as far back, at least, as the later Secondary period. The study of its animal life, as revealed in dredging, strongly confirms this, disclosing an unbroken continuity of life on the Atlantic sea-bed

from the Cretaceous period to the present time; and, as Sir Charles Lyell has pointed out, in his "Principles of Geology," the entire evidence is adverse to the idea that the Canaries, the Madeiras, and the Azores, are surviving fragments of a vast submerged island, or continuous area of the adjacent continent. There are, indeed, undoubted indications of volcanic action; but they furnish evidence of local upheaval, not of the submergence of extensive continental areas.

But it is an easy, as well as a pleasant pastime, to evolve either a camel or a continent out of the depths of one's own inner consciousness. To such fanciful speculators, the lost Atlantis will ever offer a tempting basis on which to found their unsubstantial creations. Mr. H. H. Bancroft, when alluding to the subject in his "Native Races of the Pacific States," refers to forty-two different works for notices and speculations concerning Atlantis. The latest advocacy of the idea of an actual island-continent of the mid-Atlantic, literally engulphed in the ocean, within a period authentically embraced by historical tradition, is to be found in its most popular form in Mr. Ignatius Donnelly's "Atlantis, the Antediluvian World." By him, as by Abbé Brasseur, the concurrent opinions of the highest authorities in science, that the main features of the Atlantic basin have undergone no change within any recent geological period, are wholly ignored. To those, therefore, who attach any value to scientific evidence, such speculations present no serious claims on their study. There is, indeed, an idea favoured by certain students of science, who carry the spirit of nationality into regions ordinarily regarded as lying outside of any sectional pride, that, geologically speaking, America is the older continent. It may at least be accepted as beyond dispute, that this continent and the great Atlantic basin intervening between it and Europe are alike of a geological antiquity which places the age of either entirely apart from all speculations affecting human history. But, such fancies are wholly superfluous. The idea of intercourse between the Old and the New World prior to the fifteenth century, passed from the region of speculation to the domain of historical fact, when the publication of the "Antiquitates Americanæ" and the "Grönland's Historiske Mindesmœrker," by the antiquaries of Copenhagen, adduced contemporary authorities, and indisputably genuine runic inscriptions, in proof of the visits of the Northmen to Greenland and the mainland of North America, before the close of the tenth century.

The idea of pre-Columbian intercourse between Europe and America, is thus no novelty. What we have anew to consider is, whether, in its wider aspect, it is more consistent with probability than the revived notion of a continent engulphed in the Atlantic Ocean? The earliest students of American antiquities turned to Phœnicia, Egypt, or other old-world centres of early civilisation, for the source of Mexican, Peruvian, and Central American art or letters; and, indeed, so long as the unity of the human race remained unquestioned, some theory of a common source for the races of the Old and the New World was inevitable. The idea, therefore, that the new world which Columbus revealed, was none other than the long lost Atlantis, is one that has probably suggested itself independently to many minds. Other references to America have been sought for in obscure allusions of Herodotus, Seneca, Pliny, and other classical writers, to islands or continents in the ocean which extended beyond the western verge of the world as known to them. That such allusions should be vague, was inevitable. If they had any foundation in a knowledge by elder generations of this western hemisphere, the tradition had come down to them by the oral transmissions of centuries; while their knowledge of their own

eastern hemisphere was limited and very imperfect. "The Cassiterides, from which tin is brought"—assumed to be the British Isles,—were known to Herodotus only as uncertainly located islands of the Atlantic of which he had no direct information. When Assur-yuchurabal, the founder of the palace at Nimrud, conquered the people who lived on the banks of the Orontes from the confines of Hamath to the sea, the spoils obtained from them included one hundred talents of *anna*, or tin; and the same prized metal is repeatedly named in cuneiform inscriptions. The people trading in tin, supposed to be identical with the Shirutana, were the merchants of the world before Tyre assumed her place as chief among the merchant princes of the sea. Yet already, in the time of Joshua, she was known as "the strong city, Tyre." "Great Zidon" also is so named, along with her, when Joshua defines the bounds of the tribe of Asher, extending to the sea coast; and is celebrated by Homer for its works of art. The Seleucia, or Cilicia, of the Greeks, was an attempted restoration of the ancient seaport of the Shirutana, which may have been an emporium of Khita merchandise; as it was, undoubtedly, an important place of shipment for the Phœnicians in their overland trade from the valley of the Euphrates. One favoured etymology of Britain, as the name of the islands whence tin was brought, is *barat-anna*, assumed to have been applied to them by that ancient race of merchant princes—the Cassiterides being the later Aryan equivalent, Gr. *κασσίτερος*, Sansk. *kastira*.

In primitive centuries, when ancient maritime races thus held supremacy in the Mediterranean Sea, voyages were undoubtedly made far into the Atlantic Ocean. The Phœnicians, who of all the nations settled on its shores, lay among the remotest from the outlying ocean, habitually traded with settlements on the Atlantic. They colonised the western shores of the Mediterranean at a remote period; occupied numerous favourable trading posts on the bays and headlands of the Euxine, and of Sicily and others of the largest islands; and passing beyond the straits, effected settlements along the coasts of Europe and Africa. According to Strabo (i. 48), they had factories beyond the pillars of Hercules in the period immediately succeeding the Trojan war, an era which yearly becomes for us less mythical, and to which may be assigned the great development of the commercial prosperity of Tyre. The Phœnicians were then widening their trading enterprise, and extending explorations so as to command the remotest available sources of wealth. The trade of Tarshish was for Phœnicia what that of the East has been to England in modern centuries. The Tartessus, on which the Arabs of Spain subsequently conferred the name of the Guadalquivir, afforded ready access to a rich mining district; and also formed the centre of valuable fisheries of tunny and muræna. By means of its navigable waters, along with those of the Guadina, Phœnician traders were able to penetrate far inland; and the colonies established at their mouths furnished fresh starting points for adventurous exploration along the Atlantic seaboard. They derived much at least of the tin, which was an important object of traffic, from the mines of north-west Spain, and from Cornwall; though, doubtless, both the tin of the Cassiterides and amber from the Baltic were also transported by overland routes to the Adriatic and the mouth of the Rhone. It was a Phœnician expedition which, in the reign of Pharaoh Necho, B.C. 611-605, after the decline of that great maritime power, accomplished the feat of circumnavigating Africa, by way of the Red Sea. Hanno, a Carthaginian, not only guided the Punic fleet round the parts of Libya which border on the Atlantic, but has been credited with reaching the Indian Ocean by the same route as that which Vasco de Gama successfully

followed in 1497. The object of Hanno's expedition, as stated in the "Periplus," was to found Liby-Phœnician cities beyond the pillars of Hercules. How far south his voyage actually extended along the African coast is matter of conjecture, or of disputed interpretation, for the original work is lost. It is sufficient for our purpose to know that he did pursue the same route which led in a later century to the discovery of Brazil. Aristotle applies the name of "Antilla" to a Carthaginian discovery; and Diodorus Siculus assigns to the Carthaginians the knowledge of an island in the ocean, the secret of which they reserved to themselves, as a refuge to which they could withdraw, should fate ever compell them to desert their African homes. It is far from improbable, that we may identify this obscure island with one of the Azores, which lie 800 miles from the coast of Portugal. Neither Greek nor Roman writers make other reference to them; but the discovery of numerous Carthaginian coins at Corvo, the extreme north-westerly island of the group, leaves little room to doubt that they were visited by Punic voyagers. So that there would be nothing extravagant in the assumption that we have here the "Antilla" mentioned by Aristotle. While the Carthaginian oligarchy ruled, naval adventure was still encouraged; but the maritime era of the Mediterranean belongs to more ancient centuries. The Greeks were inferior in enterprise to the Phœnicians; while the Romans were essentially unmaritime; and the revival of the old adventurous spirit with the rise of the Venetian and Genoese republics, was due to the infusion of fresh blood from the great northern home of the sea-kings of the Baltic.

The history of the ancient world is, for us, to a large extent, the history of civilisation among the nations around the Mediterranean Sea. Its name perpetuates the recognition of it from remote times as the great inland sea which kept apart, and yet united, in intercourse and exchange of experience and culture, the diverse branches of the human family settled on its shores. Of the history of those nations, we only know some later chapters. Disclosures of recent years have startled us with recovered glimpses of the Khita, or Hittites, as a great power centred between the Euphrates and the Orontes, but extending into Asia Minor, and about B.C. 1200 reaching westward to the Ægean Sea. All but their name seemed to have perished; and they were known only as one among diverse Canaanitish tribes, believed to have been displaced by the Hebrew inheritors of Palestine. Yet now, as Professor Curtius has pointed out, we begin to recognise that "one of the paths by which the art and civilisation of Babylonia and Assyria made their way to Greece, was along the great highroad which runs across Asia Minor;" and which the projected railway route through the valley of the Euphrates seeks to revive. For, as compared with Egypt, and the earliest nations of Eastern Asia, the Greeks were, indeed, children. It was to the Phœnicians that the ancients assigned the origin of navigation. Their skill as seamen was the subject of admiration even by the later Greeks, who owned themselves to be their pupils in seamanship, and called the pole-star, the Phœnician Star. Their naval commerce is set forth in glowing rhetoric by the prophet Ezekiel. "O Tyrus, thou that art situate at the entry of the sea, a merchant of the people of many isles. Thy borders are in the midst of the seas. The inhabitants of Zidon and Arvad were thy mariners. Thy wise men, O Tyrus, were thy pilots. All the ships of the sea, with their mariners, were in thee to occupy thy merchandise." But this was spoken in the last days of Tyre's supremacy.

Looking back then into the dim dawn of actual history, with whatever fresh light recent discoveries have thrown upon it, this, at least, seems to claim recognition from us,

that in that remote era the eastern Mediterranean was a centre of maritime enterprise, such as had no equal among the nations of antiquity. Even in the decadence of Phœnicia, her maritime skill remained unmatched. Egypt and Palestine, under their greatest rulers, recognised her as mistress of the sea; and, as has been already noted, the circumnavigation of Africa—which, when it was repeated in the fifteenth century, was considered an achievement fully equalling that of Columbus,—was accomplished by Phœnician mariners. Carthage inherited the enterprise of the mother country, but never equalled her achievements. With the fall of Carthage, the Mediterranean became a mere Roman lake, over which the gallies of Rome sailed reluctantly with her armed hosts; or coasting along shore, they "committed themselves to the sea, and loosed the rudder bands, and hoisted up the mainsail to the winds;" or again, "strake sail, and so were driven," after the blundering fashion described in the voyage of St. Paul. To such a people, the memories of Punic exploration or Phœnician enterprise, or the vague legends of an Atlantis beyond the engirdling ocean, were equally unavailing. The narrow sea between Gaul and Britain was barrier enough to daunt the boldest of them from willingly encountering the dangers of an expedition to what seemed to them literally another world.

Seeing then, that the first steps in navigation were taken in an age lying beyond all memory, and that the oldest traditions assign its origin to the remarkable people who figure alike in early sacred and profane history—in Joshua and Ezekiel, in Dius and Menander of Ephesus, in the Homeric poems and in later Greek writings—as unequalled in their enterprise on the sea, what impediments existed in B.C. 1400 or any earlier century, that did not still exist in A.D. 1400, to render intercourse between the eastern and the western hemisphere impossible? America was no further off from Tarshish in the golden age of Tyre, than in that of Henry the Navigator. With the aid of literary memorials of the race of sea-rovers who carved out for themselves the Duchy of Normandy from the domain of Charlemagne's heir, and spoiled the Angles and Saxons in their island home, we glean sufficient evidence to place the fact beyond all doubt that, after discovering and colonising Iceland and Greenland, they made their way southward to Labrador, and so, some way along the American coast. How far south they actually explored the New England shores is matter for dispute, but that does not, in any degree, affect the present question. Certain it is that, about A.D. 1000, when St. Olaf was introducing Christianity by a sufficiently high-handed process into the Norse fatherland, Leif, the son of Eric, the founder of the first Greenland colony, sailed from Ericsfiord, or other Greenland port, in quest of southern lands already reported as seen by Bjarni Herjulfson, and did land on various parts of the North American coast. We know what the ships of those Norse rovers were: mere oared galleys, not larger than a good fishing smack, and far inferior to it in deck and rigging. For compass they had only the same old "Phœnician star," which, from the birth of navigation, had guided the mariners of the ancient world over the pathless deep. The track pursued by the Northmen, from Norway to Iceland, and so to Greenland and the Labrador coast, was, doubtless, then as now, beset by fogs, so that "neither sun nor stars in many days appeared:" and they stood much more in need of compass than the sailors of the "Santa Maria," the "Pinta" and the "Nina," the little fleet with which Columbus sailed from the Andalusian port of Palos, to his first discovered land of "Guanahani," variously identified among the islands of the American Archipelago. Yet, notwithstanding all the advantages of a southern latitude, with its clearer skies, we

have to remember that the "Santa Maria," the only decked vessel of the expedition, was stranded; and the "Pinta" and "Nina," on which Columbus and his party had to depend for their homeward voyage, were mere coasting craft, the one with a crew of thirty, and the other with twenty-four men, with only latine sails. As to the compass, we perceive how little that availed, on recalling the fact that the Portugese admiral, Pedro Alvares de Cabral, only eight years later, when following on the route of Vasco de Gama, was carried by the equatorial current so far out of his intended course that he found himself in sight of a strange land, in 10° S. lat., and so accidentally discovered Brazil. It is thus obvious that the discovery of America would have followed as a result of the voyage of Vasco de Gama round the Cape, wholly independent of that of Columbus; but so far from the compass furnishing any help, it could only have been influential to prevent it. What befell the Portuguese admiral of King Manoel, in A.D. 1500, was an experience that might just as readily have fallen to the lot of the Phœnician admiral of Pharaoh Necho in B. C. 600, to the Punic Hanno, or other early navigators; and may have repeatedly occurred to Mediterranean adventurers on the Atlantic in older centuries. On the news of de Cabral's discovery reaching Portugal, the King despatched the Florentine, Amerigo Vespucci, who explored the coast of South America, prepared a map of the new-found world, and thereby wrested from Columbus the honour of giving his name to the continent which he discovered.

When we turn from the myths and traditions of the Old World to those of the New, we find there traces that seem not unfairly interpretable into the American counterpart of the legend of Atlantis. The chief seat of the highest native American civilisation, is neither Mexico nor Peru, but Central America. The nations of the Maya stock, who inhabit Yucatan, Guatemala, and the neighbouring region, were peculiarly favourably situated; and they appear to have achieved the greatest progress among the communities of Central America. They may not unfitly compare with the ancient dwellers in the valley of the Euphrates, from the grave mounds of whose buried cities we are now recovering the history of ages that had passed into oblivion before the Father of History assumed the pen. In actual centuries their monuments are not, indeed, so venerable; but, for America's chroniclings, they are more prehistoric than the disclosures of Assyrian mounds. The cities of Central America were large and populous, and adorned with edifices, even now magnificent in their ruins. Still more, the Mayas were a lettered people, who, like the Egyptians, recorded in elaborate sculptured hieroglyphics the formulæ of history and creed. Like them, too, they wrote and cyphered; and appear, indeed, to have employed a comprehensive system of computing time and recording dates, which, it cannot be doubted, will be sufficiently mastered to admit of the decypherment of their ancient records. The Mayas appear, soon after the Spanish Conquest, to have adopted the Roman alphabet, and employed it in recording their own historical traditions and religious myths, as well as in rendering into such written characters some of the ancient national documents. These versions of native myth and history survive, and attention is now being directed to them. The most recent contribution from this source is "The Annals of the Cakchiquels," by Dr. D. G. Brinton, a carefully edited and annotated translation of a native legal document or *titulo*, in which, soon after the Conquest, the heir of an ancient Maya family set forth the evidence of his claim to the inheritance. Along with this may be noted another work of the same class: "Titre Généalogique des Seigneurs de Totonicapan. Traduit de l'Espagnol par M. de Charencey." These two works independently illustrate the same

great national event. In one, a prince of the Cakchiquel nation, tells of the overthrow of the Quiché power by his people; and in the other a Quiché seignior, one of the "Lords of Totonicapan," describes it from his own point of view. Both were of the same Maya stock, in what is now the State of Guatemala. Each nation had a capital adorned with temples and palaces, the splendour of which excited the wonder of the Spaniards; and both preserved traditions of the migration of their ancestors from Tula, a mythical land from which they came across the water.

Such traditions of migration meet us on many sides. Captain Cook found among the mythological traditions of Tahiti, a vague legend of a ship that came out of the ocean, and seemed to be the dim record of ancestral intercourse with the outer world. So also, the Aztecs had the tradition of the golden age of Anahuac; and of Quetzalcoatl, their instructor in agriculture, metallurgy and the arts of government. He was of fair complexion, with long dark hair, and flowing beard—all, characteristics foreign to their race. When his mission was completed, he set sail for the mysterious shores of Tlapallan; and on the appearance of the ships of Cortes, the Spaniards were believed to have returned, with the divine instructor of their forefathers, from the source of the rising sun.

What tradition hints at, physiology confirms. The races of America differ less in physical character from those of Asia, than do the races either of Africa or Europe. The American Indian is a Mongol; and though marked diversities are traceable throughout the American continent, the range of variation is much less than in the eastern hemisphere. The western continent appears to have been peopled by repeated migrations and diverse routes; but when we attempt to estimate any probable date for its primeval settlement, evidence wholly fails. Language proves elsewhere a safe guide. It has established beyond question some long-forgotten relationship between the Aryans of India and Persia and those of Europe; it connects the Finn and Lapp with their Asiatic forefathers; it marks the independent origin of the Basques and their priority to the oldest Aryan intruders; it links together widely diverse branches of the great Semitic family. Can language tell us of any such American affinities, or of traces of Old World congeners, in relation to either civilised Mayas and Peruvians, or to the forest and prairie races of the northern continent?

With the millions of America's coloured population of African blood and yet speaking Aryan languages, the American comparative philologist can scarcely miss the significance of the warning that linguistic and ethnical classifications by no means necessarily imply the same thing. Nevertheless, without overlooking this distinction, the ethnical significance of the evidence which comparative philology supplies cannot be slighted in any question relative to prehistoric relations between the Old World and the New. What then can philology tell us? There is one answer, at the least, which the languages of America give, that fully accords with the legend, "white with age," that told of an island-continent in the Atlantic ocean with which the nations around the Mediterranean once held intercourse. None of them indicates any trace of immigration within the period of earliest authentic history. Those who attach significance to the references in the "Timæus" to political relations common to Atlantis and parts of Libya and Europe; or who, on other grounds, look with favour on the idea of early intercourse between the Mediterranean and the western continent, have naturally turned to the Eskuara of the Basques. It is invariably recognised as the surviving representative of languages spoken

by the Allophyliæ of Europe before the intrusion of Aryans. The forms of its grammar differ widely from those of any Semitic, or Indo-European tongue, placing it in the same class with Mongol, East African, and American languages. Here, therefore, is a tempting glimpse of possible affinities; and Professor Whitney, accordingly, remarks in his "Life and Growth of Languages," that the Basque "forms a suitable stepping-stone from which to enter the peculiar linguistic domain of the New World, since there is no other dialect of the Old World which so much resembles in structure the American languages." But this glimpse of possible relationship has proved, thus far, illusory. In their morphological character, certain American and Asiatic languages have a common agglutinative structure, which in the former is developed into their characteristic polysynthetic attribute. With this, the Eskuarian system of affixes corresponds. But beyond the general structure, there is no such evidence of affinity, either in the vocabularies or grammar, as direct affiliation might be expected to show. Elements common to the Anglo-American of the nineteenth century and the Sanskrit-speaking race beyond the Indus, in the era of Alexander of Macedon, are suggested at once by the grammatical structure of their languages; whereas there is nothing in the resemblance between the Basque and any of the North American languages that is not compatible with a "stepping-stone" from Asia to America by the islands of the Pacific. The most important of all the native American languages in their bearing on this interesting enquiry—those of Central America—are only now receiving adequate attention. Startling evidence may yet reward the diligence of students; but, so far as language furnishes any clue to affinity of race, no American language thus far discloses such a relationship, as, for example, enabled Dr. Pritchard to suggest that the western people of Europe, to whom the Greeks gave the collective name of *Κέλται*, and whose languages has been assumed by all previous ethnologists as furnishing evidence that they were precursors of the Aryan immigrants, in reality justified their classification in the same stock.

But while thus far, the evidence of language is, at best, vague and indefinite in its response to the enquiry for proofs of relationship of the races of America to those of the Old World; physiological comparisons lend no confirmation to the idea of an indigenous native race, with special affinities and adaptation to its peculiar environment, and with languages all of one class, the ramifications from a single native stem. So far as physical affinities can be relied upon, the man of America, in all his most characteristic racial diversities, is of Asiatic origin. His near approximation to the Asiatic Mongol is so manifest as to have led observers of widely different opinions in all other respects, to concur in classing both under the same great division: the Mongolian of Pickering, the American Mongolidæ of Latham, the Mongoloid of Huxley. Professor Flower, in an able discussion of the varieties of the human species, addressed to the Anthropological Institute of Great Britain in 1885, unhesitatingly classes the Eskimo as the typical North Asiatic Mongol. In other American races he notes as distinctive features the characteristic form of the nasal bones, the well-developed superciliary ridge, and retreating forehead; but the resemblance is so obvious in many other respects, that he finally includes them all among the members of the Mongolian type. If, then, the American Mongol came originally from Asia, or sprung from the common stock of which the Asiatic Mongol is the typical representative, within any such period as even earliest Phœnician history would embrace, much more definite traces of affinity are to be looked for in his language than

mere correspondence in the agglutination characteristic of a very widely diffused class of speech. But we, thus far, look in vain for traces of a common genealogy such as those which, on the one hand, correlate the Semitic and Aryan families of Asia and Europe with parent stocks of times anterior to history, and on the other, with ramifications of modern centuries. We have, moreover, to deal mainly with the languages of uncivilised races. To the continent north of the Gulf of Mexico, the grand civilising art of the metallurgist remained to the last unknown; and in Mexico, it appears as a gift of recent origin, derived from Central America. The Asiatic origin of the art of Tubalcain has, indeed, been pretty generally assumed, both for Central and Southern America; but by mere inference. In doing so, we are carried back to some mythic Quetzalcoatl: for neither the metallurgist, nor his art was introduced in recent centuries. Assuming, for the sake of argument, the dispersion of a common population of Asia and America, already familiar with the working of metals, and with architecture, sculpture and other kind redarts, at a date coeval with the founding of Tyre, "the daughter of Sidon," what help does language give us in favour of such a postulate? We have great language groups, such as the Huron-Iroquois, extending of old from the St. Lawrence to North Carolina; the Algonkin, from Hudson Bay to South Carolina; the Dakotan from the Mississippi to the Rocky Mountains; the Athabascan, from the Eskimo frontier, within the Arctic circle, to New Mexico; and the Tinné family of languages west of the Rocky Mountains, from the Youkon and Mackenzie Rivers, far south on the Pacific slope. With those, as with the more cultured languages, or rather languages of the more cultured races, of Central and Southern America, elaborate comparisons have been made with vocabularies of Asiatic languages; but the results are, at best, vague. Curious points of agreement have, indeed, been demonstrated, inviting to further research; but as yet the evidence of relationship mainly rests on correspondence in structure. The agglutinative suffixes are common to the Eskimo and many American Indian tongues. Dr. H. Rink describes the polysynthetic process in the Eskimo language as founded on radical words, to which additional or imperfect words, or affixes, are attached; and on the inflexion, which, for transitive verbs, indicates subject as well as object, likewise by addition. But, while Professor Flower unhesitatingly characterises the Eskimo as belonging to the typical North Asiatic Mongols; he, at the same time, speaks of them as almost as perfectly isolated in their Arctic home "as an island population." Nevertheless, the same structure is common to their language and to those of the great North American families already named. All alike present, in an exaggerated form, the characteristic structure of the Ural-Altaic or Turanian group of Asiatic languages.

Race-type corresponds in the Old and New World. A comparison of languages by means of the vocabularies of the two continents, yields no such correspondence. All the more, therefore, is the American student of comparative philology stimulated to investigate the significance of the polysynthetic characteristic found to pertain to so many—though by no means to all,—of the languages of this continent. The relationship which it suggests to the agglutinative languages of Asia, furnishes a subject of investigation not less interesting to American students, alike of the science of language, and of the whole comprehensive questions which anthropology embraces, than the relations of the Romance languages of Europe to the parent Latin; or of Latin itself, and all the Aryan languages, ancient and modern, not only to Sanskrit and Zend, but to the indeterminate stock which furnished

the parent roots, the grammatical forms, and that whole class of words still recognisable as the common property of the whole Aryan family. Sanskrit was a dead language three thousand years ago; the English language, as such, cannot claim to have endured much more than fourteen centuries, yet both partake of the same common property of numerals and familiar terms existing under certain modifications in Sanskrit, Greek, Latin, Slavonic, Celtic, German, Anglo-Saxon, and in all the Romance languages. Thus far the American philologist has been unable to show any such genealogical relationship pervading the native languages; or to recover specific evidence of affinities to languages, and so to races of other continents. There are, indeed, linguistic families, such as some already referred to, indicating a common descent among widely dispersed tribes; but this has its chief interest in relation to another aspect of the question.

Professor Max Müller has drawn attention to the tendency of the languages of America towards an endless multiplication of distinct dialects. Those again have been grouped by the synthetic process of Hervas into eleven families—seven for the northern continent, and four for South America. But we are as yet only on the threshold of this important branch of research. In two papers contributed by M. Lucien Adam to the "Congrès International des Americanistes," he gives the results of a careful examination of sixteen languages of North and South America; and arrives at the conclusion that they belong to a number of independent families as essentially distinct as they would have been "had there been primitively several human pairs." Dr. Brinton, one of the highest authorities on any question connected with native American languages, contributed a paper to the "American Antiquarian" (Jan. 1886), "On the study of the Nahuatl language." This language, which is popularly known as Aztec, he strongly commends to the study of American philologists. It is one of the most completely organised of Indian languages, has a literature of considerable extent and variety, and is still in use by upwards of half a million of people. It is from this area, southward through Central America, and in the great seat of native South American civilisation, that we can alone hope to recover direct evidence of ancient intercourse between the Old and the New World. But, here again, the complexities of language seem to grow apace. In Dr. Brinton's "Notes on the Mangue, an extinct language formerly spoken in Nicaragua," he states, as a result of his later studies, that the belief which he once entertained of some possible connection between this dialect and the Amyara of Peru, has not been confirmed on further examination. This, therefore, tends to sustain the prevailing opinion of scholars that there is no direct affiliation between the languages of North and South America. All this is suggestive either of an idea, such as that which Agassiz favoured in his system of natural provinces of the animal world, in relation to different types of man, on which he based the conclusion that the diverse varieties of American man originated in various centres, and had been distributed from them over the entire continent; or we must assume immigration from different foreign centres. Accepting the latter as the more tenable proposition, I long ago sketched a scheme of immigration such as seemed to harmonise with the suggestive, though imperfect evidence. This assumed the earliest current of population, in its progress from a supposed Asiatic cradle-land, to have spread through the islands of the Pacific, and reached the South American continent before any excess of population had diffused itself into the inhospitable northern steppes of Asia. By an Atlantic oceanic migration, another wave of population occupied the Canaries, Madeiras, and the Azores, and so passed to the Antilles,

Central America, and probably by the Cape Verdes, or, guided by the more southern equatorial current, to Brazil. Latest of all, Behring Strait and the North Pacific islands may have become the highway for a migration by which certain striking diversities among nations of the northern continent, including the conquerors of the Mexican plateau, are most easily accounted for.

It is not necessary to include in the question here discussed, the more comprehensive one of the existence of man in America contemporary with the great extinct animals of the Quaternary Period; though the acknowledged affinities of Asiatic and American anthropology, taken in connection with the remoteness of any assignable period for migration from Asia to the American continent, renders it far from improbable that the latest oscillations of land may here also have exercised an influence. The present soundings of Behring Strait, and the bed of the sea extending southward to the Aleutian Islands, entirely accord with the idea of a former continuity of land between Asia and America. The idea to which the speculations of Darwin, founded on his observations during the voyage of the "Beagle," gave rise, of a continuous subsidence of the Pacific Ocean, also favoured the probability of greater insular facilities for trans-oceanic migration at the supposed period of the peopling of America from Asia. But more recent explorations, and especially those connected with the "Challenger" expedition, fail to confirm the old theory of the origin of the coral islands of the Pacific; and in any view of the case, we must be content to study the history of existing races, alike of Europe and America, apart from questions relating to palæocosmic man. If the vague legend of the lost Atlantis embodies any trace of remotest historical tradition, it belongs to a modern era compared with the men either of the European drift, or of the post-glacial deposits of New Jersey and the auriferous gravels of California. When resort is had to comparative philology, it is manifest that we must be content to deal with a more recent era than contemporaries of the Mastodon, and their congeners of Europe's Mammoth and Reindeer Periods, notwithstanding the fact that the modern representatives of the later have been sought within our own Arctic circle.

Such evidence as a comparison of languages thus far supplies, lends more countenance to the idea of migration through the islands of the Pacific, than to such a route from the Mediterranean as is implied in any significance attached to the legend of Atlantis. As to the Behring Strait route, present ethnology and philology point rather to an overflow of Arctic American population into Asia. Gallatin was the first to draw attention to certain analogies in the structure of Polynesian and American languages, as deserving of investigation; and pointed out the peculiar mode of expressing the tense, mood, and voice of the verb, by affixed particles, and the value given to place over time, as indicated in the predominant locative verbal form. Such are to be looked for with greater probability among the languages of South America; but the substitution of affixed particles for inflections, especially in expressing the direction of action in relation to the speaker, is common to the Polynesian and the Oregon languages, and has analogies in the Cherokee. The distinction between the inclusive and exclusive pronoun *we*, according as it means "you and I," or "they and I," etc., is as characteristic of the Maori as of the Ojibway. Other observations of more recent date have still further tended to countenance the recognition of elements common to the languages of Polynesia and America; and so to point to migration by the Pacific to the western continent.

But this idea of a migration through the islands of the Pacific receives curious confirmation from another source. In an ingenious paper on "the Origin of Primitive Money,"[1] originally read at the meeting of the British Association at Montreal in 1884, Mr. Horatio Hale shows that there is good reason for believing that the most ancient currency in China, consisted of disks and slips of tortoise shell. The fact is stated in the great Chinese encyclopædia of the Emperor Kang-he, who reigned in the early years of the eighteenth century; and the Chinese annalists assert that metal coins have been in use from the time of Fuh-he, about B.C. 2950. Without attempting to determine the specific accuracy of Chinese chronology, it is sufficient to note here that the most ancient form of Chinese copper cash is the disk, perforated with a square hole, so as to admit of the coins being strung together. This, which corresponds with the large perforated shell-disks, or native currency of the Indians of California, and with many specimens recovered from ancient mounds, Mr. Hale regards as the later imitation in metal of the original Chinese shell money. A similar shell-currency, as he shows, is in use among many islanders of the Pacific; and he traces it from the Loo-Choo islands, across the vast archipelago, through many island groups, to California; and then overland, with the aid of numerous disclosures from ancient mounds, to the Atlantic coast, where the Indians of Long Island were long noted for its manufacture in the later form of wampum. "The natives of Micronesia," says Mr. Hale, who, it will be remembered, records the results of personal observation, "in character, usages, and language, resemble to a certain extent the nations of the southern and eastern Pacific groups, which are included in the designation of Polynesia, but with some striking differences, which careful observers have ascribed, with great probability, to influences from north-eastern Asia. They are noted for their skill in navigation. They have well-rigged vessels, exceeding sixty feet in length. They sail by the stars, and are accustomed to take long voyages." To such voyagers, the Pacific presents no more formidable impediments to oceanic enterprise than did the Atlantic to the Northmen of the tenth century.

Throughout the same archipelago, modern exploration is rendering us familiar with examples of remarkable stone structures and colossal sculptured figures, such as those from Easter Island now in the British Museum. Rude as they undoubtedly are, they are highly suggestive of an affinity to the megalithic sculptures and cyclopean masonry of Peru. Monuments of this class were noted long ago by Captain Beechy, on some of the islands nearest the coasts of Chili and Peru. Since then the megalithic area has been extended by their discovery in other island groups lying towards the continent of Asia.

Another subsidiary class of evidence of a different kind, long since noted by me, gives additional confirmation to this recovered trail of ancient migration through the islands of the Pacific to the American continent. The practice to which the Flathead Indians of Oregon and British Columbia owe their name, the compressed skulls from Peruvian cemeteries and the widely-diffused evidence of the prevalence of artificial malformation among many native American tribes, combine to indicate it as one of the most characteristic American customs. Yet the evidence is abundant which shows not only that it was a practice among rude Asiatic Mongol tribes of primitive centuries; but that it was still in use among the Huns and Avars, who contended with the Barbarians from the Baltic for the

[1] Popular Science Monthly, xxviii. 296.

spoils of the decaying Roman empire. Nor was it merely common to tribes of both continents. It furnishes another link in the chain of evidence of ancient migration from Asia to America; as is proved by its practice in some of the islands of the Pacific, as described by Dr. Pickering, and since abundantly confirmed by the forms of Kanaka skulls. By following up the traces of this strange custom, perpetuated among the tribes on the Pacific coasts both of Northern and Southern America to our own day, we thus once more retrace the steps of ancient wanderers and are carried back to centuries, when the Macrocephali of the Euxine attracted the observant eye of Hippocrates, and became familiar to Strabo, Pliny, and Pomponius Mela.

But the wanderings among the insular races of the Pacific are not limited to such remote eras. Later changes are also recorded by other evidence. The direct relationship of existing Polynesian languages is not Mongol but Malay; but this is the intrusive element of a time long subsequent to the growth of characteristic features which still perpetuate traces of Polynesian and American affinities. The number and diversity of the languages of this continent, and their essentially native vocabularies, prove that the latter have been in process of development from a remote period, free from contact with languages which appear to have been still modelling themselves according to the same plan of thought in many scattered islands of the Pacific.

Attention has been given in previous papers to the remarkable amount of culture in the languages of some of the barbarous nations of North America, traceable, as I conceive, to the important part which the orator played in their deliberative assemblies; but in any attempt to recover the history of the new world by the aid of philology we must deal with the languages of its civilised races. Among those, the Nahuatl or Aztec has been already referred to; and the Mayas have been noted as a lettered people whose hieroglyphic records, and later transcripts of writen documents, are now the object of intelligent investigation both by European and American philologists. The Maya language strikingly contrasts, in its soft, vocalic forms, with the languages of nations immediately to the north of its native area. It is that which, according to Stephens, was affirmed to be still spoken by a living race in a region beyond the Great Sierra, extending to Yucatan and the Mexican Gulf. Others among the cultured native languages which seem to invite special study are the Aymara, and the Quichua. Of these, the latter was the classical language of South America, wherein, according to its native historians, the Peruvian chroniclers and poets incorporated the national legends. It may be described as having occupied a place under Inca rule analogous to that of the Norman French in England from the eleventh to the thirteenth century. To those ancient, cultured languages of the seats of an indigenous civilisation on this continent, and with a literature of their own, attention is now happily directed. The students of American ethnology begin to realise that the buried mounds of Assyria are not richer in discoveries relative to the ancient history of Asia, than are the monuments, the hieroglyphic records, and the languages of Central America and Peru, in relation to a native social life which long flourished as an indigenous product of their own West. To this occidental Assyria we have to look for an answer to many inquiries, especially interesting to ourselves as occupants of the western continent. If its architecture and sculpture, and the hieroglyphic records with which they are enriched, are modifications of a prehistoric Asiatic civilisation, it is here that the evidence is to be looked for; and if the arts of the sculptor

and architect were brought to this continent by wanderers from an Asiatic fatherland, then those of the potter and of the metallurgist will also prove to be an inheritance from the old Asiatic hive of the nations.

From the evidence thus far adduced it appears that ethnically the American is Mongol, and by the agglutinative element his language may be classed as Turanian. The Finnic hypothesis of Rask, and the melanochroic Metis of Huxley, alike pertain to a prehistoric era of Europe of which the Finns and the Basques are assumed to be survivals; and to that elder era, rather than to any date within the remotest limits of authentic history, the languages of America seem to refer us in any search for a common origin with those of the eastern hemisphere. But a zealous comparative philologist, already referred to, has sought for linguistic traces of relationship between the Old and the New World which, if confirmed, would better harmonise with the traditions of intercourse between the maritime nations of the eastern Mediterranean and a continent lying outside of the pillars of Hercules. In these investigations he aims at determining the relations of the Aztec or Nahuatl culture and language to those of Asia. Humboldt long ago claimed for much of the former an old world derivation. It seems premature to attempt to deduce any comprehensive results from the meagre data thus far gathered. But the author of the "The Khita and Khita-Peruvian Epoch," in tracing the progress of his Sumerian race, assigns an interval of four thousand years since their settlement in Babylonia and India. In like manner, on the assumption of their migration from a common Asiatic centre, which the division of Western and Eastern Sumerian in pronouns and other details is thought to indicate, Peru it is conceived, may have been reached by a migratory wave of earlier movement, from four to five thousand years ago. Mr. Hyde Clarke indead conceives that it is quite within compass that the same great wave of migration which passed over India and Babylonia, continued to propagate its centrifugal force, and that by its means Peru was reached within the last three thousand years. But, whatever intercourse may possibly have been carried on, at such early dates, between the Old and the New World, it must be obvious, on mature reflection, that so recent a date for the peopling of South America from Asia is as little reconcilable with the very remote traces of linguistic affinity thus far adduced, as it is with any fancied relationship with a lost Atlantis of the elder world. The enduring affinities of long-parted languages of the Old World tell a very different tale. With the comparative philologist, as with the archæologist, time is more and more coming to be recognised as an all-important factor.

But, leaving the estimate of centuries out of consideration, in the researches into the origin of the peculiar native civilisation of America here referred to, the recently deciphered Akkad is accepted as the typical language of the Sumerian class. This is assumed to have started from High Asia, and to have passed on to Babylonia; while another branch diffused itself by India and Indo-China, and thence, by way of the islands of the Pacific, reached America. Hence, in an illustrative table of Sumerian words arranged under four heads, as Western, Indo-Chinese, Peruvian, and Mexican, etc., it is noted that "while in some cases a root may be traced throughout, it will be seen that more commonly the Western and American roots, or types, cross in the Indo-Chinese region." But another and older influence, related to the Agaw of the Nile region, is also traced in the Guarani, Omagua, and other languages of South America, indicating evidences of more remote relations with the Old World, and with the African continent. This is supposed

to have been displaced by a Sumerian migration by which the Aymara domination was established in Peru, and the Maya element introduced into Yucatan. Those movements are assumed to belong to an era of civilisation, during which the maritime enterprise of the Pacific may have been carried on upon a scale unknown to the most adventurous of modern Malay navigators, notwithstanding the essentially maritime character by which the race is still distinguished. All this implies that the highway to the Pacific was familiar to both continents; and hence a second migration is recognised, in certain linguistic relations, between the Siamese and other languages of Indo-China, and the Quichua and Aztec of Peru and Mexico. But the problem of the origin of the races of this continent, and of the sources of its native civilisation, is still in that preliminary stage in which the accumulation of materials on which future induction may be based is of more value than the most comprehensive generalisations.

The vastness of the American twin continents, with their Atlantic and Pacific seaboard reaching from the Arctic well nigh to the Antartic circle, furnishes a tempting stimulus to theories of migration on the grandest scale, and to the assumption of comprehensive schemes of international relations in prehistoric centuries. But they are not more substantial than the old legend of Atlantis. The best that can be said of them is that here, at any rate, are lines of research in the prosecution of which American ethnologists may employ their learning and acumen encouraged by the hope of yet revealing a past not less marvellous, and possessing a more personal interest, than all which geology has recovered from the testimony of the rocks. But before such can be more than dimly guessed at, the patient diligence of many students will be needed to accumulate the needful materials. Nor can we afford to delay the task. The Narraganset Bible, the work of Eliot, the apostle of the Indians, is the memorial of a race that has perished; and other nations and languages have disappeared since his day, with no such invaluable record of their character. Mr. Horatio Hale published in the Proceedings of the American Philosophical Society, in 1883, a paper on the "Tutelo Tribe and Language," derived from Nikonha, the last survivor of a once powerful tribe of North Carolina. To Dr. Brinton, we owe the recent valuable notes on the Mangue, another extinct language. On our own Northwestern prairies the buffalo has disappeared, and the Indian must follow. On all hands, we are called upon to work diligently while it is yet time, in order to accumulate the materials out of which the history of this western hemisphere is to be evolved.

It accords with the idea of Polynesian genealogy, that indications suggestive of grammatical affinity have been noted in languages of South America, in their mode of expressing the tense of the verb; in the formation of causative, reciprocal, potential and locative verbs by affixes; and in the general system of compound word structure. The incorporation of the particle with the verbal root, appears to embody the germ of the more comprehensive American holophrasms. Such affinities point to others more markedly Asiatic; for analogies recognised between the languages of the Deccan and those of the Polynesian group in relation to the determinative significance of the formative particles on the verbal root, reappear in some of the characteristic peculiarities of American languages. On this subject, the Rev. Richard Garnett remarked, in a communication to the Philological Society, that most of the native American languages of which we have definite information, bear a general analogy alike to the Polynesian family and to the languages of the Deccan, in their methods of distinguishing the various modifications of time; and

he adds: "We may venture to affirm, in general terms, that a South American verb is constructed precisely as those in the Tamul and other languages of Southern India; consisting, like them, of a verbal root, a second element defining the time of the action, and a third denoting the subject or person."

So far it becomes apparent that the evidence, derived alike from language and from other sources, points to the isolation of the American continent through unnumbered ages. The legend of the lost Atlantis is true in this, if in nothing else, that it relegates the knowledge of the world beyond the Atlantic, by the early maritime races of the Mediterranean, to a time of hoar antiquity in the age of Socrates, or even of Solon. But at a greatly later date the Caribbean Sea was scarcely more a mystery to the dwellers on the shores of the Ægean, than was the Baltic or the North Sea. Herodotus, indeed, expressly affirms his disbelief in "a river, called by the barbarians, Eridanus, which flows into a northern sea, and from which there is a report that amber is wont to come." Nevertheless, we learn from him of Greek traders exchanging personal ornaments and woven stuffs for the furs and amber of the North. They ascended the Dneiper as far as Gerrhos, a trading post, forty days' journey inland; and the tokens of their presence there have been recovered in modern times. Not only hoards of Greek coins, minted in the fifth century B.C., but older golden gryphons of Assyrian workmanship have been recovered during the present century, near Bromberg in Posen, and at Kiev on the Dneiper. As also, far out in the Atlantic, on the most northern island of the Azores, hoards of Carthaginian coins have revealed the traces of the old Punic voyager there; similar evidence may yet be recovered in Central America, if more ancient voyagers from Sidon, Tyre, or Seleucia, did find their way in some old forgotten century to lands that lay beyond the waste of waters, which seemed to engirdle their world.

But also the carving of names and dates, and other graphic memorials of the passing wayfarer, is no mere modern custom. When the sites of the Greenland settlements of the Northmen of the tenth century were discovered in our own day, the runic inscriptions left no room for doubt as to their former presence there. By like evidence we learn of them in southern lands, from their runes still legible on the marble lion of the Piræus, since transported to its later site in the arsenal of Venice. At Maes How in Orkney, in St. Molio's Cave on the Clyde, at Kirk Michael in the Isle of Man; and on many a rock and stone by the Baltic, the sea-rovers from the north have left enduring evidence of their wanderings. So was it with the Roman. From the Moray Frith to the Libyan desert, and from the Iberian shore to the Syrian valleys, sepulchral, legionary, and mythological inscriptions, as well as coins, medals, pottery and works of art, mark the footprints of the masters of the world. In Italy itself Perusinian, Eugubine, Etruscan, and Greek inscriptions tell the story of a succession of races in that beautiful peninsula. It was the same, through all the centuries of Hellenic intellectual rule, back to the unrivalled inscription at Abbu Simbel. This was cut, says Dr. Isaac Taylor,[1] "when what we call Greek history can hardly be said to have commenced: two hundred years before Herodotus, the Father of History, had composed his work; a century before Athens began to rise to power. More ancient even than the epoch assigned to Solon, Thales, and the seven wise men of Greece: it must be placed in the half-legendary period at which the laws

[1] The Alphabet, ii. 10.

of Dracon are said to have been enacted"—the period, in fact, from which the legend of Atlantis was professedly derived. Yet there the graven characters are, with their authentic bit of history, legible to this day, of the son of Theokles, sailing with his company "up the Nile, when King Psamatichos came to Elephantina." So it is with Egyptians, Assyrians, Phœnicians, and with the strange forgotten Hittites, whose vast empire has vanished out of the world's memory. The lion of the Piræus, with its graven runes, is a thing of yesterday, compared with the inscribed lion from Marash, covered with Hittite hieroglyphs, now in the museum at Constantinople; for the Hittite capital, Ketesh, was captured by the Egyptian Sethos, B.C. 1340. All but the name of this once powerful people seemed to have perished. Yet the inscribed stones, by which they were to be restored to their place in history, remained, awaiting the interpretation of an enlightened age.

If then, traces of the lost Atlantis are ever to be recovered in the New World, it must be by some indubitable memorial of a like kind. Old as the legend may be, it is seen that literal graphic memorials—Assyrian, Phœnician, Khita, Egyptian and Greek—still remain to tell of times even beyond the epoch assigned to Solon. The antiquaries of New England have sought in vain for runic memorials of the Northmen of the tenth century; and the diligence of less trustworthy explorers for traces of ancient records has been stimulated to excess, throughout the northern continent, with results little more creditable to their honesty than their judgment. What some chance disclosure may yet reveal, who can presume to guess? But thus far it appears to be improbable that within the continental area north of the Gulf of Mexico, evidences of the presence of Phœnician, Greek, or other ancient historic race will now be found. Certain it is that, whatever transient visits may have been paid to North America by representatives of Old World progress, no long-matured civilisation, whether of native or foreign origin, has existed here. Through all the centuries of which definite history has anything to tell, it has remained a world apart, secure in its isolation, with languages, arts, and customs essentially native in character. The nations of the Maya stock appear to have made the gratest progress in civilisation of all the communities of Central America. They dwelt in cities adorned with costly structures dedicated to the purposes of religion and the state; and had political government, and forms of social organisation, to all appearance, the slow growth of many generations. They had, also, a well-matured system of chronology; and have left behind them graven and written records, analogous to those of ancient Egypt, which still await decypherment. Whether this culture was purely of native growth, or had its origin from the germs of an Old World civilisation, can only be determined when its secrets have been fully mastered. The region is even now very partially explored. The students of American ethnology and archæology are only awakening to some adequate sense of its importance. But here appears to have been the centre of a native American civilisation whence light was slowly radiating on either hand, before the vandals of the Spanish Conquest quenched it in blood. The civilisation of Mexico was but a borrowed reflex of that of Central America; and its picture-writing is a very inferior effort imitation of the ideography of the Maya hieroglyphics.

A tendency manifests itself anew to trace the metallurgy, the letters, the astronomical science, and whatever else marks the quickening into intellectual life of this American leading race, to an Asiatic or other Old World origin. The point, however, is by no means

established; nor can any reason be shown why the human intellect might not be started on the same course in Central America, as in Mesopotamia or the valley of the Nile. If we assume the primary settlement of Central America by expeditions systematically carried on under the auspices of some ancient maritime power of the Mediterranean, or of an early seat of Iberian or Libyan civilisation, then they would, undoubtedly, transplant the arts of their old home to the New World. But, on the more probable supposition of wanderers, either by the Atlantic or the Pacific, being landed on its shores, and becoming the undesigned settlers of the continent, it is otherwise; and the probabilities are still further diminished, if we conceive of ocean wanderers, from island to island of the Pacific, at length reaching the shores of the remote continent after intervening generations had lost the traditions of their Asiatic fatherland. The condition of metallurgy as practised by the Mexicans and Peruvians exhibited none of the matured phases of an inheritance from remote generations, but partook rather of the tentative characteristics of immature native art.

We are prone to overestimate the facilities by which the arts of civilisation may be transplanted to remote regions. It is not greatly more difficult to conceive of the rediscovery of some of the essential elements of human progress than to believe in the transference of them from the eastern to the western hemisphere by wanderers from either Europe or Asia. Take the average type of emigrants, such as are annually landed by thousands at New York. They come from the most civilised countries of Europe. Yet, how few among them all could be relied upon for any such intelligent comprehension of metallurgy, if left entirly to their own resources, as to be found able to turn the mineral wealth of their new home to practical account; or for astronomical science, such as would enable them to construct a calendar, and start afresh a systematic chronology. As to letters, the picture-writing of the Aztecs was the same in principle as the rude art of the northern Indians; and I cannot conceive of any reason for rejecting the assumption of its native origin as an intellectual triumph achieved by the labours of many generations. Every step is still traceable, from the rude picturings on the Indian's grave-post or rock-inscription, to the systematic ideographs of Palenque or Copan. Hieroglyphics, as the natural outgrowth of pictorial representation, must always have a general family likeness; but all attempts to connect the civilisation of Central and Southern Amarica with that of Egypt fail, so soon as a comparison is instituted between the Egyptian calendar and any of the native American systems of recording dates and computing time. The vague year of 365 days, and the corrected solar year, with the great Sothic Cycle of 1460 years, so intimately interwoven with the religious system and historical chronology of the Egyptians, abundantly prove the correction of the Egyptian calender by accumulated experience, at a date long anterior to the resort of the Greek astronomer, Thales, to Egypt. At the close of the fifteenth century, the Aztecs had learned to correct their calendar to solar time; but their cycle was one of only fifty-two years. The Peruvians also had their recurrent religious festivals, connected with the adjustment of their sacred calendar to solar time; but the geographical position of Peru, with Quito, its holy city, lying immediately under the equator, greatly simplified the process by which they regulated their religious festivals by the solstices and equinoxes. The facilities which their equatorial position afforded for determining the few indispensable periods in their calendar were, indeed, a doubtful advantage, for they removed all stimulus to progress. The Mexican calendar is the most remarkable evidence of the civilisation attained by that people. Humboldt unhesitatingly

connected it with the ancient science of south-eastern Asia. But instead of its exhibiting any such inevitable accumulation of error as that which gave so peculiar a character to the historical chronology of the Egyptians, its computation differed less from true solar time than the unreformed Julian calendar which the Spaniards had inherited from pagan Rome. But though this suffices to show that the civilisation of Mexico was of no great antiquity, it only accords with other evidence of its borrowed character. The Mexicans stood in the same relation to Central America as the Northern Barbarians of the third and fourth century did to Italy; and the intruding Spaniard nipped their germ of borrowed civilisation in the bud. So long as the search for evidences either of a native or intruded civilisation is limited to the northern continent of America, it is equivalent to an attempt to recover the traces of Greek and Roman civilisation in transalpine Europe. The Mexican calendar stone is no more than the counterpart of some stray Greek or Roman tablet beyond the Alps; or rather, perhaps, of some Mæsogothic product of borrowed art.

We must await then, the intelligent exploration of Central America, before any certain conclusion can be arrived at relative to the story of the New World's unknown past. On the sculptured tablets of Palenque, Quiriqua, Chichenitza, and Uxmal, and on the collossal statues at Copan and other ancient sites, are numerous inscriptions awaiting the decypherment of the future Young or Champolion of American palæography. The whole region was once in occupation by a lettered race, having the same written characters and a common civilisation. If they learned of some apostle from the Mediterranean the grand invention of letters, which, as Bacon says, "as ships, pass through the vast seas of time, and make ages so distant to participate of the wisdom, illuminations and inventions, the one of the other;" then, we may confidently anticipate the recovery of some graphic memorial of the messenger, confirming the oft-recurring traditions of bearded white men who came from beyond the sea, introduced the arts of civilisation, and were reverenced as divine benefactors. It cannot be that Egyptian, Assyrian, Hittite, Phœnician, and other most ancient races, are still perpetuated by so many traces of their wanderings in the Old World; that the Northmen's graphic runes have placed beyond all question their pre-Columbian explorations; and yet that not a single trace of Mediterranean wanderers to the lost Atlantis survives. In Humboldt's "Researches," a fragment of a reputed Phœnician inscription is engraved. It was copied by Ranson Bueno, a Franciscan monk, from a block of granite which he discovered in a cavern in the mountain chain, between the Orinoco and the Amazon. Humboldt recognised in it some resemblance to the Phœnician alphabet. We must remember, however, what rudely traced Phœnician characters are; and as to their transcriber, it may be presumed that he had no knowledge of Phœnician. Humboldt, says of him: "The good monk seemed to be but little interested about this pretended inscription," though, he adds, he had copied it very carefully

The lost Atlantis, then, lies still in the future. The earlier studies of the monuments and prehistoric remains of the American continent seemed to point conclusively, to a native source for its civilisation. From quipu and wampum, pictured grave-post and buffalo robe, to the most finished hieroglyphs of Copan or Palenque, continuous steps appear to be traceable whereby American man developed for himself the same wondrous invention of letters which ancient legend ascribed to Thoth or Mercury; or, in less mythic form, to

the Phœnician Cadmus. Nor has the generally accepted assumption of a foreign origin for American metallurgy been placed as yet on any substantial basis. Gold, as I believe, was everywhere the first metal wrought. The bright nugget tempted the savage, with whom personal ornaments precede dress. It was readily fashioned into any desired shape. The same is true, though in a less degree, of copper; and wherever, as on the American continent, native copper abounds, the next step in metallurgy is to be anticipated. With the discovery of the economic use of the metals, an all-important step had been achieved, leading to the fashioning of useful tools, to architecture, sculpture, pictorial ornamentation, and so to ideography. The facilities for all this were, at least, as abundant in Central and Southern America as in Egypt. The progress was, doubtless, slow; but when the neolithic age began to yield to that of the metallurgist, the all-important step had been taken, The history of this first step is embodied in myths of the New World, no less than of the Old. Tubalcain, Dædalus, Hephæstus, Vulcan, Vœlund, Galant, and Wayland the Saxon smith-god, are all mere legendary variations of the first mastery of the use of the metals; and so, too, the new world has Quetzalcoatl, its divine instructor in the same priceless art.

It forms one of the indisputable facts of ancient history that, long before Greece became the world's intellectual leader, the eastern Mediterranean was settled by maritime races, whose adventurous enterprise led them to navigate the Atlantic. There was no greater impediment to such adventurous mariners crossing the Atlantic in earliest centuries before Christ, than at any subsequent date prior to the revival of navigation in the fifteenth century. It would not, therefore, in any degree, surprise me to learn of the discovery of a genuine Phœnician, or other inscription; or, of some hoard of Assyrian gryphons, or shekels of the merchant princes of Tyre "that had knowledge of the sea," being recovered among the still unexplored treasures of the buried empire of Montezuma, or the long deserted ruins of central America. Such a discovery would scarcely be more surprising than that of the Punic hoards found at Corvo, the most westerly island of the Azores. Yet it would furnish a substantial basis for the legend of Atlantis, akin to that which the runic monuments of Kingiktorsoak and Igalikko supplied in confirmation of the fabled charms of a Hesperian region lying within the Arctic circle; and of the first, actual glimpses of the American mainland by Norse voyagers of the tenth century, as told in more than one of their old Sagas. But until such evidence is forthcoming, the legendary Atlantis must remain a myth, and pre-Columbian America be still credited with a self-achieved progress.

ROYAL SOCIETY OF CANADA.

TRANSACTIONS

SECTION III.

MATHEMATICAL, PHYSICAL AND CHEMICAL SCIENCES.

PAPERS FOR 1886.

I.—*Presidential Address.*

By CHARLES CARPMAEL, M.A.

(Read May 25, 1886.)

Last year, when I was elected President of this Section, I hoped to be able to find ample time for the preparation of my Address. Various unforeseen circumstances have, however, combined to prevent me from devoting to this purpose as much time as I had desired, and I have been consequently obliged to confine myself to the few hastily prepared and meagre remarks which I am now about to address to you.

Four years ago, this Society was organized by His Excellency the Marquis of Lorne, and as I was one of those who had the honour of being appointed by His Excellency an officer in this Section, it seems to me that it will not be out of place for me now, to refer to some of the objects which were aimed at, and to the hopes which were entertained, at the time of the organization of the Society, at least so far as they directly affect this Section. These objects were, first, to establish a bond of union between the scattered workers in different parts of the Dominion, by bringing them together once a year for interchange of ideas, and discussion of papers. Next, it was hoped that means would be found to publish valuable scientific papers in Canada, which otherwise would either be published in very inferior style or in a curtailed form, or at best appear in the transactions of foreign societies and be little known in Canada. The knowledge that a really valuable paper once prepared would find publication in Canada free of cost, would also, it was expected, act as a great stimulus to Canadian workers in Science. Another object of the Society was to provide a body, whom the Government might refer to when requiring information on scientific points, and who might call the attention of the Government, to the desirability of aiding in scientific researches which were likely to be of national benefit.

With regard to the first of these objects, viz., the bringing together from time to time of some of the most eminent scientific workers in the Dominion, it is one of the utmost importance in every country. The solitary worker in Science is but too apt to get into one groove of thinking and working, but let him meet with others who are interested in the same kind of work, let him talk with them of the work he is engaged in, or listen to what they have to say of what they are doing, and the chances are that he will get some idea which will be of use to him. It may be, that he will be asked a question the answer to which requires a more detailed reasoning out of some point than he has yet given to it, and this will lead him to a more thorough grasp of his own idea; or it may possibly turn out, on his attempting to elaborate his proof, that his former reasoning has been fallacious, even if his conclusions have not been false. In such a case, if he has not yet written a paper on the subject, the paper when written will be free from errors which

might otherwise have occurred in it, and if the paper has been already written, it will give the author an opportunity of removing the blemishes before publication; or if the error which is detected should seem to require it, he may withdraw the paper altogether.

Dr. Wilson, the President of this Society for the present year, recently said to me that, when he first came to Canada many years ago from Edinburgh, there were two things that he missed above all others; the first was the want of a good library to which he could refer (for there was then no library worthy of the name in Toronto), and the second was the absence of all opportunity of discussing with others, interested in such work as he might be engaged in, the various points to which his attention might be turned during the progress of his investigations. So many points would be discussed, he added, at meetings of the Royal Society of Edinburgh and in other learned societies, that the author of any literary or scientific work would generally have his views so modified and enlarged before its completion, that he would find it impossible to say, how much was really due to his own researches, and how much had been suggested in these discussions.

It must not be forgotten that what we, as scientific workers, should aim at, is not so much the production of a large number of papers, as that such as we may produce shall contain new scientific truths, new scientific deductions from old principles, or new and improved methods of deducing facts already known, and that they may be as far as possible free from error. When once a paper is printed, in which deductions are drawn from erroneous premises, or erroneous deductions from true premises, this paper may be read by many who will be unable to detect the errors and who may copy them and so spread not truth but error. When once widely spread, it is often the work of a very long time before the erroneous ideas thus promulgated become eradicated.

A good instance of this difficulty is the erroneous impression very generally held by mathematicians as to specific gravity and density. The specific gravity of a substance is commonly taken by them as the *weight* of a unit of volume of that substance, thus making the specific gravity vary from place to place, and introducing unneccessary complication into all calculations involving this quantity. The density of the substance is on the other hand taken as the *mass* of a unit of volume of the substance. Every practical physicist must know that specific gravity, like density, is determined by a comparison of the *masses* of equal volumes of the given and a standard substance; yet in all our elementary text books on hydrostatics, at least in the English language, the above way of defining specific gravity is still retained, although in the elementary text books on mechanics it is clearly pointed out that what are ordinarily called standards of weight are, in the mathematician's way of defining weight and mass, in reality standards of mass.

In France also, at least a few years ago, both terms were used; and there, according to Millar, in tables of specific gravity the unit was usually water at zero cent., while in tables of density the unit was water at 4°c.

If in these countries errors or unnecessary complications, once introduced, are so persistent, in Canada, or at any rate in Ontario, they are likely to be still more so. We are here having introduced into our schools a uniform series of text books, so that if any errors creep into them, not the pupils in one school only, but in a whole generation, will be brought up in the same errors, which will not therefore stand so good a chance of being corrected by the after mixing together of pupils from different schools.

Although then, whatever precautions we may take, as Science advances, we shall

find that we have much to unlearn as well as to learn, it is a matter of no little importance, that we should do all we can to prevent errors coming in at the fountain head, that is in the original papers in which new ideas are promulgated ; and we should therefore not only endeavour to make the papers which we ourselves write as free as possible from errors, but, by discussing those which are brought before us, endeavour, if we can, to detect and have corrected, before publication, the defects in such papers as may have been written by others.

Some of the papers which have been laid before us at the meetings during the past four years have been fairly well discussed; it would, however, it seems to me, be a great benefit to the Society were the discussions still more frequent and more freely participated in. Perhaps the ignorance which has generally prevailed heretofore, as to the nature of the papers to be read, by preventing the members present from giving any prior consideration to the subject matter of the paper, may have greatly hindered discussion. An effort has been made this year to overcome this difficulty, by printing a short account of the contents of some of the papers, and it is to be hoped that, in future, members will always endeavour to prepare, when possible, such a short abstract of their papers as will give a fair idea of their contents. There is also another way in which members may aid in this matter. It is to be assumed that any criticism of a paper is made with the object of bringing out the truth, and of preventing errors from appearing in our printed volume ; and that any questions that may be asked, are either for the purpose of further elucidating some point which is obscure in the paper, or from the desire of the member asking the question to obtain further information on a point on which he happens to be ignorant. In either case, the member presenting the paper should do his best to elucidate the point ; if he has been in error, it is for his own credit that the paper should not be printed with errors in it, and if there is no error, the question or criticism may show that some point has not been very plainly brought out, and the author may see that, by a slight verbal alteration, his meaning may be made clearer. But even if there is no error and no real want of clearness in the paper, but the criticism has been made through false reasoning of a member who has started or taken part in the discussion, the member presenting the paper having presumably the subject at his fingers' ends, should be able to point out at what point the criticism fails, and the consideration due from one member of this Society to another should make him willing to do this, and to do it courteously, even though his superior knowledge of the subject shews him that the objections which are raised are frivolous or absurd. I cannot but hope that the discussions will, in the future, prove to be perhaps the most instructive and interesting feature in our meetings, as I have found them at meetings of some other societies.

Let us turn now to the next point which I mentioned as among the principal objects in the foundation of the Society, viz., the publication in Canada of valuable scientific papers. On this point we have reason to congratulate ourselves on success. We have had presented to us and published in our Transactions, papers on a variety of subjects, mathemical, chemical and engineering, in numbers satisfactory, considering the small number of members, and of quality decidedly high. Most of these papers have been contributed by members of the Society. It is to be regretted that a larger number of papers have not been contributed by outsiders, and we should all endeavour to get scientific workers with whom we may be acquainted to occasionally present papers, as we should

thus add to the interest of these meetings and to the value of our Transactions. We should also gain this future advantage, that should a vacancy arise in our Section we should be able to judge by the value of the papers, which had been contributed to us, whom it was desirable to elect to fill the vacancy.

With regard to the next function of the Society, namely, that of advising the Government on scientific points, we have had, as the President has already informed you, for the last two years, a committee to coöperate with a committee of the British Association, in urging on the Government the advisability of providing for continuous tidal observations in Canada. In January last, these committees, with some members of the Board of Trade of Montreal, waited on the Government, and urged that provision be made in the estimates for this purpose. The defecit this year has, however, made it difficult to get any matter taken up that requires expenditure, and although all the members of the Government seem to acknowledge the necessity of accurate observations, the cost of obtaining them prevents them for the present from taking the matter up.

Having made these few remarks and suggestions on the work of the Society, I should like to take this opportunity, the best that will perhaps ever occur to me, to point out to you how you could aid the particular branch of scientific work with which I am more particularly connected as Superintendent of the Meteorological Service of the Dominion of Canada. You are probably all of you aware that the Dominion Government has for many years past made annually an appropriation for the maintenance of this service. In doing this, they have principally in view the providing for storm warnings for the use of mariners, and for daily weather predictions for the benefit of farmers and others to whom a fairly accurate knowledge for a short time in advance of what weather may be expected is of commercial value; and although the obtaining statistics of climate has not been entirely neglected, the vast bulk of the annual grant is absorbed for the two purposes which I have named.

The observations which can be immediately made use of for these two purposes are not sufficient for the purpose of tracing out local peculiarities in climate, or for tracing these peculiarities to their causes in the local surroundings. To do this we must have the statistics which are collected by the Dominion Government supplemented by others which are not being collected by them, and the greater portion of which they cannot be expected to go to any considerable expense in obtaining. In Europe and also in the United States there are meteorological societies which collect much valuable information. These societies collect and print statistics, and also publish many papers on Meteorology, and are supported solely by the subscriptions of the members. In the United States, in addition to the work now performed by the Signal Service, which includes that which was formerly undertaken by the Smithsonian Institute, many of the individual States have weather bureaus of their own.

In Canada we have not many men of means and leisure who are sufficiently interested in scientific researches to make them willing not only to devote their time to the systematic taking of observations, but to purchase instruments and pay for the printing of results. To meet in some measure this difficulty, the Meteorological Service, in the case of individuals who reside in districts from which sufficient observations are not already received, and who are willing to take observations gratis, furnishes the necessary instruments and provides for the publication of the observations. Notwithstanding this, there

are large portions, even of the Provinces which have long been settled, for which our climatological statistics are either very meagre or are altogether wanting. The observations of which we have most need are those of precipitation. Ontario and Manitoba are the only two of our Provinces in which we have any approach to adequate observations of rainfall. In the other Provinces we know the rainfall at a few isolated stations, but not at nearly enough to form any idea as to the amount at intermediate points. The amount of precipitation depends so much on the configuration of the land, that a very much larger number of observing stations is required for this than for the other elements which together make the climate of a district. To meet this want, the Departments of Agriculture of Ontario and Manitoba have got agents all over these Provinces to report the rain and snowfall. The reports are forwarded to the Meteorological Office at Toronto, and abstracts of the results are furnished monthly by that office to the Local Governments. By this means, an amount of information has been collected which has enabled me to prepare maps showing the precipitation with a fair degree of accuracy over the greater portion of these two Provinces. These maps show that the precipitation in some parts of Ontario is about double what it is in others, and in Manitoba the differences are relatively about the same. If we had attempted a few years ago, before we were receiving these additional reports, to draw any conclusions as to the distribution of rainfall over these Provinces from such as we did receive, our results would have been altogether erroneous, and in the other Provinces we are still unable to give any information, except at a few isolated points.

The same may be said to a great extent in regard to the daily range of temperature, which also varies a good deal from place to place, although not to the same extent as the rainfall.

Now, it occurred to me that if I could interest the members of this Society in this subject, they might in turn interest friends living in some of the less thickly populated portions of their respective Provinces, and get them to volunteer as observers ; or they might, perhaps, by bringing the matter to the notice of the Local Governments, induce them to do in other Provinces, something like what is now being done in Ontario and Manitoba. By this means, great service would be rendered to the Science of Meteorology, while the information would at the same time be of immediate practical importance. I hope, therefore, that you will bear this want in mind, and endeavour, as opportunity may occur, to aid me in a matter of importance to Science, and to the advancement of the Dominion and of the individual Provinces.

II.—*The Genetic History of Crystalline Rocks.*[1]

By T. STERRY HUNT, M.A., LL.D. (Cantab.)

(Read in abstract, May 25, 1886.)

§ 1. In a preceding essay on the the Origin of Crystalline Rocks,[2] we have considered at length the different views hitherto maintained as to the mode of their production, and have set forth what we have called the "crenitic hypothesis." It is proposed in the following pages to examine still farther the new hypothesis in some of its aspects, to show how far the conception of a single consolidated igneous mass under the combined action of water and heat may be made to explain satisfactorily the various facts in the history of the earth's crystalline crust, and thus to reconcile many of the contradictions which still divide the geological world as to the relations of stratified and massive crystalline rocks. Hence the title of the present essay.

Of the great divisions adopted by the Wernerian school in geology, those of Primary and Secondary correspond respectively to Original and Derived rocks, and were supposed to represent earlier and later periods in geologic time; the name of "Transition" being applied to the rocks of an intermediate period, believed to mark the passage from the conditions of the Primary to those of the Secondary age. The name of "Tertiary" given to the rocks of a still later age, and marking a subsequent period in the process of derivation, needs no explanation. By the geologists of the Huttonian school the rocks, called "Primary" or "Original" by the Wernerians, were imagined to be in many, if not in all cases, Secondary or Derived rocks, the materials of which, got from the disintegration of preëxisting masses, had been arranged by water, and subsequently transformed by combined mechanical and chemical agencies into their present crystalline condition; in accordance with which hypothesis they have been called "Metamorphic" rocks. By rejecting, as their master Hutton had done, all "inquiry into the first origin of things," or "the commencement or termination of the present order," and by teaching that the rocks, called by Wernerians "Primary" and "Transition," were for the most part, if not wholly, metamorphosed portions of derived rocks, which themselves, in their prolongation into other regions, could be recognized as Secondary or as Tertiary strata, the Huttonians have sought to destroy the chronological value of the Wernerian terminology. With the abandonment of the Huttonian or so-called "metamorphic" doctrine, now shown to be false, so far at least as

[1] A paper was presented to this Society by the writer, in May, 1885, with the title of "The Geognosy of Crystalline Rocks," and was accepted for publication in the Transactions, but subsequently withdrawn. In the abstract of the paper then read, and afterwards published in the Canadian Record of Science, the phenomena of stratification, alike in endogenous veinstones and in eruptive rocks, were discussed with reference both to the crenitic process and to the hypothesis of eliquation. The present paper is, under a new title, an extension and development of that of last year.

[2] Trans. Roy. Soc. Can., Vol. ii. Sec. iii. pp. 1–67.

regards the Secondary or Tertiary age of crystalline stratified rocks, we are naturally led back to the nomenclature of Werner and his school, which should be equally acceptable to endoplutonists and to neptunists, whether the latter adopt the Chaotic hypothesis set forth by De la Beche and Daubrée, or the Crenitic hypothesis more recently maintained by the present writer in the essay just cited.

§ 2. The term "crystalline rocks" is conveniently used in geology to designate those original aggregates of which crystalline silicates make an essential part. Such silicates may, however, be associated in these aggregates with quartz, or with oxyds like magnetite, with carbonates, as in limestones and dolomite, and even with phosphates, as apatite, or with sulphates, as karstenite and gypsum. By a certain license the term may also be extended to masses of definite hydrous silicates, such as serpentine and pinite, which are in great part amorphous and colloidal, and also to uncrystalline silicates, often hydrated, and of indefinite composition, such as palagonite, tachylite, pitchstone, and obsidian. The silicates having the composition of serpentine and of pinite assume, in some cases, proper crystalline forms; palagonite is by heat readily changed in large part into a crystalline zeolite; while glassy silicates, such as obsidian, by devitrification, are in like manner resolved more or less completely into crystalline species. Hence rock-masses, including or even made up of these various uncrystalline materials, may all be regarded as inchoately crystalline, and for geognostical purposes may be conveniently classed with the crystalline rocks into which they graduate.

§ 3. When stratified masses of quartz, calcite, dolomite, and karstenite are found among contemporaneous crystalline silicated rocks, they generally enclose indigenous crystalline silicates, which give them a title to be regarded as parts of the accompanying crystalline series. The mineral species just named have, however, in other cases become aggregated in crystalline rock-masses in times and under conditions which did not permit the genesis of such species as feldspars, micas, amphibole, and pyroxene, which are the most characteristic silicates of the crystalline rocks. Hence we find beds of crystalline quartz, limestone, dolomite, karstenite, and gypsum interstratified with uncrystalline rocks of detrital origin, and of Secondary or Tertiary age. It is worthy of note, however, that the conditions for the production of certain mineral silicates have continued in later ages, as is shown by the frequent formation of zeolitic, pectolitic, and other crystalline silicates in younger and uncrystalline rocks, and even down to our own time, and, moreover, by the occurrence among uncrystalline sediments of later geological periods, of deposits of serpentine, sepiolite, and glauconite. The history of both zeolitic and pectolitic silicates (as formed by secretions in basic rocks, and as generated in deep-sea ooze, and in the channels of thermal waters,) has been discussed at some length in the preceding essay, but there are facts in relation to the other silicates just mentioned which are of such importance in connection with the origin of crystalline rocks as to merit consideration in this place.

§ 4. Two examples of crystalline silicates related to zeolites in composition, which are found injecting organic remains remains in palæozoic limestones, have been observed by Sir J. W. Dawson, and were farther described and analyzed by the present writer in 1871. The first of these is from a Silurian limestone which is found near Woodstock, in the province of New Brunswick, and consists almost wholly of comminuted organic remains, including fragments of trilobites, gasteropods, brachiopods, and joints and plates of

small encrinites, the whole cemented by calcite. The pores of the crinoidal remains are filled by a peculiar silicate, which is well seen in sections or on surfaces etched by an acid. Surfaces thus treated show a congeries of curved, branching, and anastomosing cylindrical rods of the injecting mineral, sometimes forming a complete network, and exhibiting under a microscope coralloidal forms, with a white, frost-like, crystalline aspect resembling the variety of aragonite known as *flos ferri*. The same crystalline mineral, as observed by Dawson, occasionally fills the interstices between the larger fragments of organic forms in the limestone, and, as he observes, "was evidently deposited before the calcite which cements the whole mass."

§ 5. The limestone in question is nearly pure, containing very little magnesia or iron-oxyd, and leaves, after the action of cold dilute chlorhydric acid, five or six-hundredths of insoluble residue, which is the mineral in question mixed with about one-fourth its weight of siliceous sand. The silicate is of a pale grayish-green color when seen in mass, and, losing water, becomes bright reddish-brown by calcination. It is partially decomposed by strong heated chlorhydric acid, and completely by hot sulphuric acid, which dissolves alumina, ferrous oxyd, magnesia, and small portions of alkalies, leaving flocculent silica, which is readily separated by a solution of carbonate of soda from the accompanying quartz-grains. Thus analyzed, the mineral, which under a lens appeared wholly crystalline and homogeneous, save the accompanying quartz, yielded silica 38.03, alumina 28.88, ferrous oxyd 18.86, magnesia 4.25, potash 1.69, soda 0.48, water 6.91. The atomic ratio of this for protoxyds, alumina, silica and water is very nearly 1 : 2 : 3 : 1, which, abstracting the water, is that of zoisite; the hydrous silicate jollyte being 1 : 2 : 3 : 2. I have given to this crystalline silicate, which is of curious interest alike for its composition and the mode of its occurrence, the name of hamelite for the Rev. Dr. Hamel, Rector of Laval University, Quebec.[1]

§ 6. The second silicate above referred to is not unlike hamelite in its characters and manner of occurrence, though differing somewhat in atomic ratios. It was found in a mass of fossiliferous limestone said to be from a locality in the island of Anglesea, and including, "besides a small coral-like body referred to the genus *Verticillopora*, joints and plates of crinoids, small spiral gasteropod shells, with fragments of brachiopods, and a sponge-like organism with square meshes." All of these organic forms are more or less penetrated with a greenish silicate, which fills the cavities of the gasteropods, the central canal of the crinoids, and the pores of the Verticillopora. It has also replaced, or filled, the spongy fibres, and injected the minute cells of some of the crinoidal fragments, though many of these are solid throughout, in which respect the specimen differs from that from New Brunswick described above, where the infiltration of the crinoidal remains is much more complete and perfect. Sir J. W. Dawson, to whom we owe these observations, supposes that in both cases the infiltration took place while the remains were still recent

§ 7. Decalcified surfaces of this limestone from Anglesea show similar appearances to those presented by the New Brunswick specimen, and the casts of the gasteropodous shells, two millimetres in length, are in some cases perfect. The limestone is nearly pure, with the exception of a little fine yellow ochreous matter which is insoluble in dilute

[1] Amer. Jour. Science, 1871, i. 379; also J. W. Dawson, The Dawn of Life, pp. 120–123, with figure of a portion of infiltrated crinoid on p. 103.

chlorhydric acid, and remains suspended in the solution, but is easily separated by washing from the pale grayish-green silicate. This equals about three-hundredths of the weight of the limestone. When ignited in the air it assumes a bright fawn color, and under a lens contrasts strongly with the colorless grains of quartz with which it is mixed. Its chemical characters were like those of hamelite, and analyzed in the same manner it gave, after deducting 21.0 per cent. of insoluble sand, the following composition: Silica, 35.72, alumina 22,26, ferrous oxyd 21.42, magnesia 6.98, potash 1.49, soda 0.67, water 11.46 = 100.00.[1] This gives for protoxyds, alumina, silica, and water very nearly the atomic ratios 3 : 4 : 7 : 4; but we are not sure of its homogeneous character. A silicate very like this in aspect and mode of occurrence has been found in a band of fossiliferous limestone near the base of the coal-measures in southern Ohio, but has not yet been chemically examined.

§ 8. In connection with these minerals should be noticed a greenish fibrous asbestiform silicate, elsewhere described by the writer, which occurs in veins traversing the anthracite and the carbonaceous shales of the coal-measures at Portsmouth, Rhode Island, either without admixture or mingled with pyrites, or penetrating white quartz, and also coating the fragments of the crumbling disintegrated anthracite. It is a hydrous silicate of alumina, ferrous oxyd, magnesia, and alkalies, more basic than those above described, yielding the atomic ratios of 4 : 4 : 6 : 3, and, though differing in structure, is near to prochlorite or voigtite in composition.[2]

§ 9. We have elsewhere explained how solutions which would otherwise have yielded zeolitic minerals or epidote may, by exchanging their lime and alkalies for magnesia and ferrous oxyd, have given rise to aluminous double silicates like those just described. In like manner, non-aluminous solutions which might have yielded pectolite, apophyllite, or related silicates, by exchange with magnesian or ferrous solutions, may give origin to silicates like serpentine, sepiolite, and probably to glauconite. The magnesian silicates just named occur, as is well known, in aqueous deposits, by themselves or mingled with carbonate of lime, in strata of palæozoic or even of cenozoic age, while serpentine fills the Eozoon of more ancient times.

§ 10. The probable relations between the protoxyd-silicates and glauconite are worthy of notice. By the latter name is designated a soft greenish amorphous mineral sometimes found in the cavities in basic amygdaloidal rocks, but more abundantly in sandstones and marls, among which it often forms beds, with but little admixture, and is commonly called "green-sand." It is well known that glauconite is met with filling the shells of foraminifera and other marine organisms, from early geological times, and even occurs in the same manner in recent foraminifera in various seas. The mode of its occurrence in these cases is similar to that of the aluminous double silicates in organic forms from limestones, as described above. The composition of glauconite is very variable; and, while essentially a hydrous silicate of potash and iron-oxyd, it may contain of alumina from one or two up to twelve hundredths or more, and of magnesia from traces up to six hundredths. Indeed, a so-called green-sand from the calcaire grossier, according to Berthier, is rather a highly ferrous serpentine, containing, silica 40.0, ferrous oxyd 24.07, magnesia 16.6, lime 3.3, alumina 1.7, water 12.6 = 98.9.[3]

[1] Amer. Jour. Science, 1871, ii. 57.

[2] Trans. Roy. Soc. Can., Vol. iii. Sec. iii. p. 70.

[3] Beudant, Traité de Minéralogie, ii. 178. See also Report Geol. Survey of Canada, 1866, p. 231.

§ 11. Their variations show that the material in question is a mixture, and render it difficult to fix its real constitution. According to the multiplied analyses of Haushofer, the iron present in glauconite is for the most part in the ferric condition, the ferrous oxyd in various examples ranging from three to seven hundredths. The formula proposed by him represents glauconite as containing 6.3 of ferrous oxyd, 8.3 of potash, and 9,6 of water, with 22.7 of ferric oxyd and 3.6 of alumina, giving for the atomic ratios of protoxyds, sesquioxids, silica, and water, 1 : 3 : 9 : 3.[1] The very variable quantity of alumina found in glauconites may, however, well be owing to a zeolitic admixture; and if we hazard the conjecture that the large proportion of ferric oxyd therein is due to a partial oxydation of what was originally a ferro-potassic silicate, we should have for its composition before peroxydation (deducting the alumina as a zeolite with the above atomic ratios, like faujasite) a silicate with the ratios for protoxyds, silica, and water, of 3 : 9 : 3, corresponding to sepiolite and to an unknown pectolitic silicate intermediate between pectolite and apophyllite, which may be supposed to have given rise alike to talc, to sepiolite, and to glauconite. The variable amounts of magnesia in glauconite itself would thus be due to an admixture of sepiolite. The reaction of such a soluble pectolitic compound, having a lime-potash base like apophyllite, with the dissolved magnesian salts in sea-water would generate a magnesian silicate having the ratio of talc and sepiolite (which latter forms beds in Tertiary sediments), and with ferrous solutions, by a similar double decomposition, might yield a ferro-potassic silicate like glauconite. It is well known that, under proper conditions, decaying organic matters acting upon sediments containing ferric oxyd reduce this and give rise to such solutions, in which ferrous carbonate is often associated with a proportion of an organic acid. Such a process of solution and redeposition in forms of siderite and pyrites goes on in sedimentary deposits through this agency. This would permit the conditions necessary to produce glauconite with the pectolitic silicate, which in the absence of the iron-solution would generate sepiolite by reaction with magnesian salts.

§ 12. The variations in the composition of glauconite-like minerals, and the existence in silicates similar to it in their mode of occurrence, of more or less alumina and magnesia, probably corresponding, as suggested above, to admixtures of zeolite and sepiolite, are farther illustrated by the following analyses by the writer. I is a typical glauconite from the green-sand beds of the cretaceous series in New Jersey; II, a glauconite, remarkable for its fine green colour, which forms layers in the Cambrian (Potsdam) sandstone at Red Bird, Minnesota; III, a similar material found in a Cambrian sandstone on the island of Orleans, near Quebec. The results, after deducting siliceous sand, are calculated for one hundred parts, and the whole of the iron is represented as ferrous.[2]

	I.	II.	III.
Silica	50.70	46.58	50.7
Ferrous oxyd	22.50	20.61	8.6
Magnesia	2.16	1.27	3.7
Lime	1.11	2.49	—
Alumina	8.03	11.45	19.8
Potash	5.80	6.96	8.2
Soda	0.75	0.98	0.5
Water	8.95	9.66	8.5
	100.00	100 00	100.00

[1] Cited in Dana's System of Mineralogy, 5th ed., p. 462.

[2] Geology of Canada in 1863, p. 486: also Rep. Geol. Surv. of Canada 1863–69, p. 232.

§ 13. The crenitic hypothesis advanced by the present writer in the essay already cited, to explain the aqueous origin of the mineral species which make up alike the granites and the crystalline stratified rocks, supposes that from an early period watery solutions analogous to those which, in later times, have given rise to zeolitic and pectolitic minerals, played an important part in the chemistry of the earth. The double silicates of alumina and lime or alkalies, then dissolved, are conceived to have been the source not only of the feldspars and the zeolites, but of prehnite, epidote, garnet, muscovitic micas, and tourmalines, and, by their reactions with magnesian and ferrous solutions, of the chlorites and the highly protobasic micas. At the same time the dissolved protoxyd-silicates not only gave rise to species like pectolite and apophyllite, but by similar reactions, to pyroxene, amphibole, chrysolite, serpentine, talc, sepiolite, and glauconite, and, by decomposition through carbonic dioxyd, to carbonate of lime. In both cases the solutions, like those in later zeolite-bearing rocks, carried free silica and iron-oxyd, which were deposited as quartz and magnetite and hematite. These silicated solutions, according to this hypothesis, resulted primarily from the action of permeating waters at high temperatures, under pressure, upon the universal stratum of basic plutonic rock, and secondarily from their action upon the displaced portions of the stratum, which, in a more or less modified form, have appeared in all geological periods as erupted basic rocks. These, in their secreted minerals, show us in later times, and on a smaller scale, the process which, in previous ages, built up great masses of indigenous and endogenous crystalline rocks. To what extent these deposits, more or less concretionary in their origin and their arrangement, were laid down horizontally, and to what extent in inclined or vertical layers, as in many veinstones, is a question which will be discussed farther on in this essay.

§ 14. Having thus briefly restated the crenitic hypothesis so far as it is related to the classes of rocks already noticed, we have to consider in the next place the question of exoplutonic or eruptive rocks. It will be remembered that the existence of such rocks, having an igneous origin, was not admitted by the Wernerians, who conceived not only all endogenous rocks, but also all exotic masses, except modern lavas, to be of aqueous origin. By the earlier Huttonians, who understood better the geological importance of the eruptive rocks, these were looked upon as results of the fusion of deeply buried detrital materials, themselves derived from similar rocks of higher antiquity. The hypothesis of great chemical changes to explain the genesis of many crystalline rocks from such material, by what was comprehensively designated as "metamorphism," and generally involved a supposed metasomatic process, was devised at a later day by the disciples of Hutton. Haidinger and Bischof may be looked upon as the originators of that view of metasomatic changes in rock-masses by aqueous action which, from its supposed analogy with the phenomena giving rise to what are called "pseudomorphous shapes" or "pseudocrystals," has been infelicitously described as "pseudomorphism on a broad scale."

§ 15. The stratiform arrangement, which extends to the intimate structure of crystalline masses such as gneisses and mica-schists, is by endoplutonists supposed to be due to movements in an imperfectly homogeneous semi-fluid material, dependent on unequal cooling and the rotation of the globe, and to be analogous to the banded structure apparent in lavas and furnace-slags. In the exoplutonic hypothesis, on the contrary, it is maintained that the internal movements in such material, when forced outwards and upwards through the earth's superficial crust, have given to the masses that laminated structure and that

arrangement of the constituent elements which, alike by Wernerians and Huttonians, are regarded as evidences of deposition from water. This latter or explutonic view was clearly expressed by Poulett Scrope, sixty years since, in his "New Theory of the Earth," published in 1825, wherein he imagines the granite to have formed the original surface of the globe, and supposes that movements in extruded portions of the mass compressed beneath overlying sediments gave to it the gneissic structure. He insists upon the friction of its elements "as they were urged forward in the direction of their plane surfaces towards the orifice of protrusion, along the expanding granite beneath, the laminæ being elongated and the crystals forced to arrange themselves in the direction of the movement." This view was adopted, though without acknowledgment, by J. D. Dana in 1843, when he argued that the schistose structure of gneiss and mica-schist is not a satisfactory evidence of sedimentary origin, since erupted rocks may assume a laminated srrangement.[1]

§ 16. The same notion has continued to find favor among geologists of the plutonist school up to the present time. Poulett Scrope himself, in rewriting his famous treatise on Volcanoes, after a lapse of thirty-seven years, restates his argument with great precision. He therein supposes that the primitive material of the globe, so far as known, was an aggregate consisting essentially of feldspar, quartz and mica, in a crystalline or granular condition. This material, which was impregnated with water and highly heated, possessed a certain plasticity, and when extruded by pressure took upon itself a stratiform structure, being "bodily forced up the axial fissure of dislocation in crumpled zigzag folds or upright walls of vertical laminated rock." To show to what extent this view had met the approval of other geologists, Scrope farther observed, "The late Mr. Sharpe and Mr. Darwin, as is well known, concurred in the opinion here given, that at least as respects the oldest or fundamental gneiss, its foliated structure is due not to original sedimentary deposition, but to the movement of the particles under great pressure, while the mass was in a condition of imperfect igneous fluidity. Prof. Naumann has still more recently advocated the same view, which is, however, resisted by Lyell, Murchison, Geikie, and others."[2]

§ 17. The same view has very recently been brought forward by Joh. Lehmann, who maintains, with Scrope, that the schistose structure in crystalline rocks is no evidence of aqueous deposition, but is imposed upon them by the process of extrusion. The Saxon granulites, according to Lehmann, were intrusive masses, which consolidated among sedimentary strata far below the surface, and being afterwards forced up by great pressure, took upon themselves a banded schistose arrangement, the adjacent strata, more or less impregnated by the granulitic material, appearing as micaceous gneisses and mica-schists.[3] The whole granulitic series of Saxony may be described as made up of fine-grained binary gneisses and mica-schists, and has been by the present writer elsewhere referred to the younger gneissic or Montalban series of crystalline rocks.[4]

§ 18. An example of the resuscitation of the views of Poulett Scrope in North America

[1] Scrope, Considerations on Volcanoes, etc.. 1825, p. 22. See also J. D. Dana, On the Analogies Between Modern Igneous Rocks and the so-called Primary Formations, 1843; Amer. Jour. Science, 1843, xlv. 104-129, and Trans. Roy. Soc. Can., Vol. iii. Sec. iii. p. 13.

[2] Scrope on Volcanoes, 2nd ed., 1862, as revised in 1872, pp. 300-365.

[3] Joh. Lehmann: Untersuchungen über die Enstehung der Altkrystallinen Schiefergesteine, 1884. Not having been able to consult this work, I am indebted for a notice of its argument to a review in the Amer. Jour. Science, xxxiii. p. 39.

[4] Trans. Roy. Soc. Can., Vol. i. Sec. iv. p. 194.

is found in a recent note by Prof. H. Carvill Lewis on the crystalline schists of eastern Pennsylvania. A belt of these which crosses the Schuylkill near Philadelphia, long ago described by H. D. Rogers, and since by the present writer,[1] includes a band of granitoid gneiss succeeded by micaceous gneisses and micaceous schists, often garnetiferous, comprising a layer of serpentine with steatite and dioritic rocks, the whole representing both the older and the younger gneissic series so well known in eastern North America as Laurentian and Montalban. The rocks in this belt, notwithstanding their stratiform character, are, in the opinion of Lewis, "of purely eruptive origin, consisting of syenites, acid gabbros, trap-granulites, and other igneous rocks, often highly metamorphosed. It is the outer peripheral portions of this zone to which attention is here directed. While the rocks are massive on the centre, this outer portion has been enormously compressed, folded and faulted, with the result of producing a tough banded porphyritic fluxion-gneiss." Lewis supposes "a recrystallization of the old material under the influence of pressure-fluxion," by which he conceives the feldspar to have been recrystallized. "In similar manner the biotite has been made out of the old hornblende, garnets have been developed, and the quartz has been granulated and optically distorted by the pressure." In another example mentioned by him, a belt of sphene-bearing amphibolite schist, described as included unconformably in the mica-schists of Philadelphia, is supposed by Lewis to be "a highly metamorphosed intrusive dyke of Lower Silurian age. The original augite or diallage has been completely converted into fibrous hornblende, and the influence of pressure is shown in the perfectly laminated character of the schist, in the close foldings produced, and in the minute structure of the rock." "The chemical changes and interchanges of elements which might result from a loosening of molecular combinations under extreme pressure," and their subsequent rearrangement to form new compounds, suggest to Lewis great possibilities in the so-called "mechanical metamorphism," now advocated by some to replace the discredited dogma of chemical metamorphism, which has hitherto played such an important part among a school of geologists.[2]

§ 19. Thus, while the ancient Wernerians maintained the direct deposition of granite from aqueous solution in a chaotic ocean, the plutonists, from Poulett Scrope in 1825 to Darwin, Naumann, Lehmann, and Lewis, assert the igneous origin not only of granites, but of gneisses and micaceous and amphibolic schists, and the followers of the Huttonian or metamorphic school hold an untenable and an illogical position between the two,—deriving the materials of both these rocks from a primary granitic mass, whose origin is unaccounted for, and whose supposed transformations chemistry cannot explain.

§ 20. It remains to notice, in connection with the neptunian, the plutonic, and the metamorphic hypotheses regarding the sources and the geognostic relations of the crystalline rocks, a view that has been proposed to explain the attitude of certain apparently exotic masses: which is that their present position is due neither to deposition from solution, nor to intrusion in a fluid or plastic condition, but to local movements which have permitted portions of rigid rock to displace and even penetrate softer and more yielding materials in their vicinity. Examples of this are described by Stapff as seen in the St. Gothard tunnel in the Alps, where great masses of serpentine have been caused to

[1] See Hunt, Azoic Rocks, pp. 10–15 and 200; also Trans. Roy. Soc. Can., Vol. i. Sec. iv. p. 171.

[2] H. C. Lewis, Proc. British Association, in Nature, Oct. 8, 1885, p. 560.

traverse adjacent schistose strata; the solid condition of the introducing rock being made evident by the accompanying breccia, consisting of its fragments.[1] There is reason to believe that such instances are not uncommon, and that in many cases the phenomenon of intrusion is due to the superior hardness of the intruding rock, broken beds or masses of which are forced through softer strata; the conditions being the reverse of those which attend plutonic or volcanic injections. The notion that rocks when in a solid condition may be intruded among others, is found in the pages of more than one writer on geological questions, but so far as the writer is aware, is for the first time clearly and satisfactorily defined in the description of Stapff, which is an important conception gained for the student of geognosy.

§ 21. The endoplutonists, as we have seen, have sought to explain the laminated structure of certain crystalline rocks, not, like the exoplutonists, by the pressure attendant on extrusion, but by movements in an imperfectly fluid material in which, during refrigeration, a separation of solid matters and a process of eliquation were going on. The possible production in this manner alike of unstratified and stratiform crystalline rocks from an igneous mass is ingeniously set forth by Thomas Macfarlane in his studies of the geology of Lake Superior.[2] He notes first, the occurrence of fragments of denser and more basic hornblendic aggregates enclosed in lighter and less basic granitoid masses, and from these facts, and the composition and specific gravity of granitic veins penetrating the masses, conjectures that these various products represent different stages in crystallization from a primitive magma, the first-separated portions from which were more basic, and the later more siliceous.

If this took place when the mass was undisturbed, a granitoid rock would be formed; but if while it was in motion, "hornblendic and micaceous schists and gneisses were most probably the results of this process, and the strike of these would indicate the direction of the current at the time of their formation." The material thus separated, notwithstanding its greater specific gravity, is supposed to have formed at the surface of the molten mass, as a result of cooling; but in Macfarlane's view "there arrived a time when, from some cause or other, these first rocks were rent or broken up, and the crevices or interstices became filled with the still fluid and more siliceous material which existed beneath them. This gradually solidified in the cracks, or in the spaces surrounding the fragments, and the whole became again a consolidated crust above a fluid mass of still more siliceous material," which by subsequent movements would again be intruded in the form of veins in the broken crust. This restatement of the hypothesis of the solidification of a molten globe from above downwards, already taught by Naumann,[3] serves to show how the endoplutonist school explains the origin alike of massive and of stratiform crystalline rocks, and may be compared with the detailed statement of the exoplutonist view as set forth by Poulett Scrope.

§ 22. The broad distinction sometimes drawn between stratified crystalline rocks, as of indigenous and aqueous origin, and unstratified rocks, as intruded or exotic masses of igneous origin, thus finds no place in the hypotheses of the plutonic schools, according to

[1] See Trans. Roy. Soc., Can., Sec. i. Vol. iv. pp. 112-4, where details and references are given.

[2] Geological Features of Lake Superior, Canadian Naturalist, May, 1867.

[3] Trans. Roy. Soc. Can., Vol. ii. Sec. iii. p. 10.

both of which these two classes of rocks have come directly from a primitive fused mass, which was either simple or had become complex through differentiation. The Huttonian school also, which teaches that eruptive rocks, in many if not in all cases, were originally sediments, which, as a result of profound alteration, have lost their bedded structure, arrives, by a different route, at a conclusion not unlike that of the plutonists; namely, that the differences between stratified and unstratified rocks are due solely to superinduced structure and geognostic relations. Those who, for the most part unfamiliar with any other view, acquiesce in the metamorphic hypothesis of Hutton and his followers, now so popular with a school of writers on geology, are scarcely prepared, without farther study, to criticise intelligently either the plutonic or the crenitic hypothesis of the origin of crystalline rocks. The latter, as set forth in a previous easy, and concisely resumed in § 13 of the present, supposes that the source of all crystalline rocks is to be sought in a previously solidified primary plutonic material. The elements of these rocks have been derived, in part indirectly, by aqueous solution, and in part directly from this original mass, more or less profoundly altered alike by previous aqueous action, and by differentiation through crystallization and eliquation. By this hypothesis, as we have elsewhere attempted to show, we may hope to lay the foundation of a rational geogeny and geognosy.

§ 23. We have already, in the preceding essay, considered at some length the views of those who, noting the existence of predominant types of crystalline rocks, have sought to explain their origin by supposing the presence beneath the earth's solid crust of two distinct layers of molten rock: an upper, lighter, and more viscous siliceous or so-called acidic stratum, the material of trachytes, granites, and gneiss; and a lower, heavier, and more fluid basic layer, the source of doleritic and basaltic rocks,—a view which was put forth by John Phillips,[1] defended by Bunsen, and elaborated and more definitely formulated by Durocher. To this are opposed the modified view, by Von Waltershausen, of a gradual passage downward in a liquid mass from a more acidic to a more basic portion, and the entirely distinct view held and defended by the present writer as the basis of the crenitic hypothesis. According to this, the plutonic underworld, so far as it intervenes directly in geologic phenomena, is an essentially homogeneous basic rock, not in a state of simple and original igneous fusion, but solidified, and subsequently impregnated with water, which communicates a certain plasticity to the highly heated mass, and, moreover, dissolves and removes therefrom the materials of the trachytic annd granitic rocks,—which are thus primarily of aqueous origin.

§ 24. This process implies secular changes in the composition of the plutonic stratum, which are moreover local, since the conditions of solution and upward percolation

[1] John Phillips, Manual of Geology (1855), p. 556, after distinguishing between rocks like granite and trachyte, containing quartz and trisilicates (orthoclase and albite), and rocks with more basic silicates, such as labradorite, pyroxene and chrysolite, suggests "the probability that granite appears among the oldest of the igneous family because of the gradual cooling of the internal fluid mass, which, bringing into action the unequal relation to heat of the silicates and trisilicates, separated these groups in zones. The former (usually more complicated) mixture might remain liquid, while the latter (usually less complicated) separated themselves in a solid state. On this supposition the trisilicated zone, being of less specific gravity, would be uppermost. It would be first consolidated, and might receive a coating of strata, while the silicated mass remained liquid below." On this hypothesis, he adds: "The trachytic lava of one active volcano, and the doleritic lava of another, would seem to indicate the stage to which, in those places respectively, the volcanic process had arrived."

will vary in different areas, and during different periods in the same area. It involves also a corresponding change in the nature of the materials dissolved, so that differences greater or less are to be looked for in the composition alike of eruptive plutonic and of crenitic rocks, when those of different areas and different ages are compared. The evidence of some such changes, even independent of aqueous action, in the composition of the plutonic mass, did not escape the acute observation of Durocher, and was in 1857 discussed by him in his remarkable essay on Comparative Petrology.[1] To this I called attention in 1858, stating that in Durocher's view the two strata of molten mineral matter imagined by him, "occasionally more or less modified by a partial crystallization and eliquation, or by refusion," give rise to the principal varieties of acidic and basic crystalline rocks.[2]

§ 25. This view was stated with great clearness by Durocher, who declared: "The magmas which have produced the igneous rocks are to be compared to metallic baths which, holding many metals in a state of fusion, separate in solidifying into different alloys, according to the circumstances of their solidification,"—these circumstances being "conditions of an exterior rather than of an interior order." Subsequently, in comparing a basic and highly aluminous phonolite with a trachytic porphyry, more siliceous and less aluminous, he remarks that an admixture of these in equal proportions would give the composition of a normal trachyte, and expresses the opinion that the rocks thus compared are probably "the two opposite products of an eliquation which took place in the midst of the liquid mass, as in the formation of two opposite alloys into which a metallic bath is so often seen to separate." These phenomena of eliquation he conceived to be very general in nature: "They must have taken place beneath the surface of the earth, and in its caverns and crevices, as well as at the surface."

§ 26. The probability of this view is apparent to all chemists who have studied the phenomena due to the crystallization and the different melting and solidifying points of metallic alloys, as, for example, the separation of lead from its silver-bearing alloy in the Pattinson process, and the eliquation of this metal from its alloy with copper. It was adopted by Macfarlane in 1867, in explanation of the relations of more or less basic hornblendic and granitic rocks, already cited in § 21, and finds a striking illustration in the late experiments of Fouqué and Michel Lévy on the artificial production of crystalline mineral species from fused vitreous mixtures. From such a mixture, containing the elements of six parts of chrysolite, two of pyroxene, and six of labradorite, kept at a heat near whiteness for forty-eight hours, there separated crystals of chrysolite, 0.5 millimetre in diameter, together with magnetite and spinel (picotite); a vitreous magma still remaining, from which crystallized, at a lower temperature, macled crystals of labradorite, with pyroxene, magnetite, and spinel, as before. It is apparent that with a greater lapse of time, and the formation of larger crystals of chrysolite, which has a specific gravity of about 3.4, these would, under the influence of gravity, subside, together with magnetite and spinel, from a fused glass holding the elements of pyroxene and feldspar, the more so as the density of fused doleritic and basaltic material is less than 2.8. From such a slowly cooling mixture the process of eliquation would, under favorable conditions, give rise to a highly chrysolitic aggregate, on the one hand, and to a dolerite with little or no chrys-

[1] Annales des Mines, xi. 217. A translation of this into English by Haughton was separately published in Dublin, in 1859.

[2] Chemical and Geological Essays, p. 3.

olite, on the other. Moreover, if, as is probable, there are conditions under which pyroxene may be separated in a similar manner from the feldspathic element, we should have a farther differentiation, giving rise to heavier and highly pyroxenic portions on the one hand, and to lighter and more feldspathic portions on the other.

§ 27. The careful student of crystalline rocks will have noticed in ntaure many examples of variations in different portions of eruptive masses, which find a ready explanation in a process of partial solidification and eliquation, as suggested by Durocher and illustrated by the experiments of Fouqué and Michel Lévy. This is well displayed in certain rocks intruded among the Ordovician strata of the St. Lawrence valley, near Montreal, and forming the hills known as Rougemont, Montarville, and Mount Royal. These, as I have long since described them, are essentially doleritic, but present very great differences in the proportions of their mineralogical elements in contiguous parts. Thus in some portions of these masses we have a pyroxene and labradorite rock, in which these two elements are pretty equally distributed; while in other portions the rock is almost wholly a black, coarsely crystalline pyroxene, with but an insignificant proportion of the feldspathic element. Elsewhere the arrangement of these two species gives rise to stratiform structure.

§ 28. As described by me in 1863,[1] for Mount Royal, "mixtures of augite and feldspar are met with, constituting a granitoid dolerite, in parts of which the feldspar predominates, giving rise to a light grayish rock. Portions of this character are sometimes found limited on either side by bands of nearly pure black pyroxenite, giving at first sight the aspect of stratification. The bands of these two varieties are found curiously contorted, and . . . seem to have resulted from movements in a heterogeneous pasty mass, which have effected a partial blending of an augitic magma with one more feldspathic in nature." In the doleritic mass of Montarville, the alternation of a coarse-grained variety of dolerite, porphyritic from the presence of large crystals of pyroxene, with a finer-grained and whiter variety, is noticed, the two "being arranged in bands whose varying thickness and curving lines suggest the notion that they have been produced by the flow and the partial commingling of two fluid masses." Of this stratiform structure, it was then said, it seems to be due to "the arrangement of crystals during the movement of the half-liquid crystalline mass, but it may in some instances arise from the subsequent formation of crystals, arranged in parallel planes."[2]

§ 29. The feldspars mentioned, as shown in the published analyses by the writer, are near in composition to labradorite. The composite rocks described also contain, besides pyroxene, more or less magnetite and menaccanite, with chrysolite. This last species is for the most part distributed sparsely through these rocks, but occasionally, like

[1] Geology of Canada, 1863, pp. 665, 667, and Amer. Jour. Science, 1864, xxxviii. 175–178.

[2] Farther illustrations of this were given by the author in a communication to the Boston Society of Natural History, January 7, 1874: "Among these was a specimen shown from Groton, Connecticut, in which a large angular fragment of strongly banded micaceous gneiss is enclosed in a fine-grained eruptive granite, the mica plates in which are so arranged as to show a beautiful and even stratification in contact with the broken edges of the gneiss, but at right angles to the strata of the latter. Another example is afforded by the eruptive diabase from the mesozoic sandstone of Lambertville, New Jersey, which is conspicuously marked by light and dark bands, due to the alternate predominance of one or the other of the constituent minerals; and still another is a fine-grained dark micaceous dolerite dike from the Trenton limestone at Montreal, in which the abundant laminæ of mica (probably biotite) are arranged parallel to the walls of the dike." Chem. and Geol. Essays, p. 186.

the pyroxenic element, occurs in predominant quantity. An example of this is seen in a coarsely granitoid chrysolitic aggregate, exposed with the same characters, over an area of many hundred square feet, on Montarville. The chrysolite in this rock is in irregular crystalline masses from five to ten millimetres in diameter, and was separately analyzed, as was the black pyroxene, found in still larger and well defined crystals in the mass, and also the feldspathic element, selected as carefully as possible. For an analysis of the rock as a whole, it was attacked in fine powder successively by dilute sulphuric acid and by a weak solution of soda, the portions thus dissolved being analyzed separately, as well as the insoluble residue. The relative proportions of these being 55.0 per cent of the former and 45.0 of the latter, it became possible to calculate the composition of the rock as a whole.

§ 30. In the following table, I is the composition of the feldspar; II, the pyroxene; III, the chrysolite; IV, the soluble portion (55.0 per cent), chiefly chrysolite; V, the insoluble portion (45.0 per cent); VI, the rock as a whole, including an undetermined amount of titanic oxyd with the iron-oxyd. For the purposes of comparison we give under VII the composition of the supposed basic magma of the earth's interior, as deduced by Bunsen from the mean of several analyses of basic eruptive rocks, and under VIII the composition of the same, as calculated by Durocher, who, however, admits a range in proportions through geologic time which includes the figures adopted by Bunsen. The last five analyses are necessarily calculated for one hundred parts, and the whole of the iron is represented as ferrous oxyd, although an unknown proportion exists in a higher state of oxydation.

	I.	II.	III.	IV.
Silica	53.10	49.40	37.17	37.3
Alumina	26.80	6.70	—	3.0
Lime	11.48	21.88	—	—
Magnesia	0.72	13.06	39.68	33.5
Ferrous oxyd	1.35	7.03	22.54	26.2
Soda	4.24	0.74	—	—
Patash	0.71	—	—	—
Volatile	0.60	0.50	—	—
	99.00	100.11	99.39	100.0

	V.	VI.	VII.	VIII.
Silica	49.35	42.70	48.47	51.5
Alumina	18.92	10.16	14.78	16.0
Lime	18.36	8.27	11.87	8.0
Magnesia	6.36	21.29	6.89	6.0
Ferrous oxyd	4.51	16.45	15..38	13.0
Alkalies	2.50	1.13	2.61	4.0
	100.00	100.00	100.00	98.5

§ 31. The process which has thus given rise in parts of a mountain mass of dolerite to considerable areas of a rock containing over 21.0 of magnesia, and more than one half its weight of chrysolite, and in other parts of the same mass to an aggregate of pyroxene and labradorite, almost, and in some cases wholly, destitute of chrysolite, is readily explained if we admit a separation from a still fluid mass of the previously crystallized and

heavier chrysolite by a process like that imagined by Durocher. It will be noticed that the insoluble and non-chrysolitic portion separated from the Montarville rock (V) is near in composition to an ordinary dolerite, or to the normal basic types of Bunsen and Durocher. We may conjecture that dolerites of average composition are, perhaps, themselves products separated by eliquation from a more chrysolitic aggregate.

§ 32. The segregation of groups of crystals which takes place in the devitrification of glasses shows, within narrow limits, the process of differentiation through crystallization in a homogeneous mass. The operation of this process on a larger scale, giving rise to remarkable mineralogical differences, is well shown in the careful studies by Fouqué, in 1873, on the recent eruptive rocks from Santorin. The ordinary type of these lavas examined by him was a vitreous mass enclosing crystals of feldspars, with pyroxene, chrysolite, and magnetite. The feldspar was chiefly labradorite, but its association with crystals of albite, and with some anorthite, was established. Druses in this same rock were, however, filled with anorthite, associated with a pyroxene and a chrysolite, both differing from those contained in the paste in being less dense, and in containing less ferrous oxyd. In an obsidian-like rock from the same region were rounded masses, sometimes a metre in diameter, gray in color, and made up of crystalline anorthite, with pyroxene, chrysolite, titanite, and magnetite, with very little paste. The small portions of alumina found in the analyses of these pyroxenes were apparently, according to Fouqué, derived from adherent anorthite, but another variety of pyroxene, seemingly very pure, and freed from anorthite, contained 12.4 per cent of alumina, which he regards as an integral part of the mineral,—a true aluminous pyroxene. Fouqué made use, in these investigations, of concentrated fluorhydric acid which readily attacks the coarsely powdered rock, dissolving alike the vitreous paste, albite, labradorite, and anorthite, but leaving behind the pyroxene and chrysolite, which, like amphibole, are but slightly attacked by the acid,[1] or, like staurolite and zircon, resist its action.

§ 33. Durocher, in his statement of the hypothesis of eliquation as applied to eruptive rocks, of which this process of segregation just noticed is but an illustration, raises, in connection with the question of differentiation, another not less important. He concludes from his comparative studies that, "in the long course of the ages which divide the Primary and the Tertiary periods from each other," there have been changes "in the composition of the fluid mass which nourished the eruptions"; and, moreover, that in the case of the acidic layer—the source of the granitic and trachytic rocks—"there was a diminution of eight or nine hundredths in the proportion of silica, and of one-fifth in the potash, while the proportions of lime and iron-oxyd were almost doubled, and that of the soda tripled. Similar changes, according to him, have taken place in the basic layer, represented by dolerites, basalts, melaphyres, from the comparative study of which he

[1] Fouqué, Nouveau procédé pour l'analyse médiate, et son application aux laves de la dernière eruption de Santorin; in abstract, Comptes Rendus de l'Académie des Sciences, June, 1873, lxxvi. 1181. Also, *in extenso*, Mem. des Savants Étrangers, de l'Acad. des Sciencies, xxii. no. 11. For farther details of this use of fluorhydric acid, see Fouqué and Michel Lévy, Minéralogie Micrographique, p. 116. Crystals of zircon from different localities, according to the late observations of Ed. Linnemann, when exposed for ten days to the vapors of fluorhydric acid, crumble to a white powder, which is not attacked by fluorhydric acid nor by aqua regia, and is pure silicate of zirconia, equal to 93 and 94 per cent. of the crystals. The matters attacked are silicates of various bases, including alkalies, lime, magnesia, iron, zinc, and alumina. (Sitz. Berichte Kais. Acad. Wissenschaft, 11, 1885, in Chem. News, Nov. 6, 1885.)

concludes that "in the ferro-calciferous layer from the Primary to the Tertiary period. . . . there was a sensible diminution of silica and potash, and a notable augmentation of soda and lime." Of these changes, "the diminution of silica and potash in the modern rocks, both of the acidic and basic groups," was by Durocher explained by supposing that while these imaginary igneous layers remain distinct from each other, there is, nevertheless, in each a partial separation of these elements, by gravity, resulting in an accumulation of silica and potash in their upper portions, and of lime in their lower portions. The augmentation in the proportion of soda was by him referred to a special and independent cause, the supposed "intervention of sea-water in the formation of igneous products during the latter geological periods," which, as he writes, would explain "the considerable increase of soda in the more modern of the igneous rocks, whether they be derived from the acidic or the basic layer."

§ 34. While Durocher included in the category of eruptive rocks certain masses, such as those of magnetite, serpentine, and various amphibolic rocks, for which an igneous origin is not admissible (so that some of his data may be questioned), the correctness of his important generalizations, which suggest a vast geogenic problem, cannot be contested. As regards his proposed explanation, it is easy to conceive that a separation by specific gravity might possibly cause such variations, alike in the acidic and the basic layer, that the ejections in the course of ages from successively lower portions of each of these would show the gradual diminution observed in the proportions of silica and potash, as well as the augmentation of lime. To this ingenious explanation, however, it is to be objected that it is based upon the unproved and, in the opinion of many modern philosophers, the untenable hypothesis of a molten substratum, and, moreover, one divided into two distinct zones. The whole of the phenomena in question, moreover, admit of a simpler and, it is believed, a more probable explanation, by the crenitic hypothesis. This, as we have seen, supposes a constant and progressive differentiation of an original basic plutonic mass through the action of water, which removes therefrom, in the elements of orthoclase and quartz—the chief constituents of granitic rocks,—preponderant proportions of silica and potash: an action which would result at last in the partial exhaustion of the lixiviated portion of the basic rock, which, with the diminution of the amount of available silica and potash, would finally yield to the solvent action of the waters only the elements of the more basic feldspars. As a result of this continued process, the crenitic products themselves will naturally show a diminution in the proportions of silica and potash, by reason of the progressive exhaustion of the source of these, while this residual portion of basic rock will not only exhibit a reduction in the proportions of silica and potash, but a relative increase in the proportion of lime. Moreover, the sodium and magnesium-chlorids which, from the results of subaerial decay, find their way into the surface-waters, which subsequently pass downwards in the process of lixiviation, may, by double exchange, effect the displacement of potash and the fixation of soda and magnesia in the basic mass, as explained farther on.

§ 35. This hypothesis thus explains at the same time the origin of the highly silicic and potassic rocks, represented by the granites, and the conversion of the original plutonic stratum into a more and more basic material, progressively richer in alumina, soda, lime, and magnesia. It moreover requires that the long-continued lixiviation of a given area of plutonic rock should at length reach a point at which water could no longer remove

from it the elements of orthoclase and quartz. With the disappearance of the latter would come the elements of the more basic feldspars, such as andesite and labradorite, as well as protoxyd-silicates, which together predominate in the norites and the diorites, characteristic crenitic rocks of the later crystalline series, such as the Norian and Huronian, which succeed the granites and the granitoid gneisses of the earlier periods.

The crenitic hypothesis, as we have elsewhere seen, involves the conception that all trachytic and granitic rocks are primarily of crenitic origin, and that penetrating granitic masses, when not, as is the case with most granitic veins, directly crenitic or endogenous masses, are displaced portions of older crenitic deposits. The first-formed granitic layer itself, it is held, may become softened under the combined influences of water and internal heat, and being then displaced, may appear in an eruptive form.

§ 36. The question here arises as to the respective parts which crenitic action, on the one hand, and crystallization and eliquation, on the other, may play in the genesis of various types of crystalline rocks. It is apparent, from the illustrations which we have given, that by the latter process aggregates could, in palæozoic times, be formed in which chrysolite makes more than one half the weight of the mass, and others in which either pyroxene or labradorite may largely predominate. The texture and the general facies of these different mineral aggregates, not less than their geognostic relations, however, suffice to distinguish them from crenitic deposits of somewhat similar composition. It was from a failure to recognize these differences that the original Wernerians denied or minimized the significance of igneous rocks, on the one hand, and that the later plutonists of both schools on the other hand, have argued the igneous origin of rocks of manifestly crenitic origin. The Wernerians, from the stratiform structure of gneiss, which they ascribed to its aqueous origin, argued for a similar origin for the granite into which it appears to graduate, while the plutonists from an analogous structure in undoubtedly igneous rocks conclude the igneous origin of gneiss. We have already noticed this laminated or stratiform character in plutonic rocks, the true significance of which, as evidences of igneous flow, should not be lost sight of.

§ 37. It must be kept in mind that the crenetic process, unlike eliquation, modifies the primary mass not only by abstraction, but by addition, since the surface-water which, by the hypothesis, is the dissolving agent, will bring with it in solution, in varying proportions, salts of calcium and magnesium, of potassium and of sodium, the action of all which upon the heated plutonic mass will effect certain interchanges, resulting in the fixation of bases like magnesia, whose silicated compounds are comparatively insoluble in the circulating waters, and perhaps in a substitution of soda for lime. It is not improbable that potassic solutions from some local source[1] could thus be introduced, and give rise by their action upon a doleritic mass, either integral or partially differentiated by eliquation, to a material so rich in potash as to furnish the elements of leucite, which has the oxygen-ratios of an andesite.

[1] While in ordinary spring-waters the proportion of potassium to sodium salts is small, seldom exceeding two or three hundredths of these bases, calculated as chlorids, I have shown that in an alkaline spring-water from palæozoic shales at St. Ours, Quebec, containing in a litre about 0.3 gramme of alkalies, chiefly as carbonates and chlorids, the potassium thus calculated equalled 25 per cent. In the case of the water of the St. Lawrence River it equals 16 per cent, and of the Ottawa River 32 per cent. See for a discussion of the question of potassium in natural waters, the writer's Chem. and Geol. Essays, pp. 135–137.

§ 38. The genesis of rocks like phonolite, which are essentially made up of a feldspar having the orthoclase-ratios, with an admixture of a more basic silicate, as nephelite or a zeolite, can, however, hardly be explained save as an educt of crenitic action, like trachyte and granite. It represents, however, a period in the history of the plutonic mass when, from a diminution of silica, the production of quartz ceases, and more basic feldspathic or zeolitic compounds begin to replace the orthoclase. When, from compounds like these, in which the proportion of protoxyds to alumina falls below the normal oxygen-ratio of 1 : 3, we pass to those, like the muscovitic micas, most tourmalines, and the pinite-like minerals, with a diminished proportion of protoxyds, we have probably in all cases to do either with crenitic products or with the direct results of subaerial decay.

§ 39. Fouqué and Michel Lévy, in their recent experiments, have shown us how to form artificially, from mixtures in igneous fusion, in which the proportions of elements were prearranged, crystalline aggregates containing leucite with labradorite, pyroxene, magnetite, and spinel, and others holding chrysolite in similar associations. The problem which lies behind this discovery is to determine how the materials are so grouped in nature's laboratory as to yield the mixtures necessary, in the one case, for the production of a leucitophyre, and in the other for a chrysolitic dolerite. The research of the natural processes by which these combinations are reached has been the object of the preceding inquiry into the results of eliquation, on the one hand, and of the solvent and replacing action of percolating waters, on the other.

§ 40. It is farther to be noted that the experiments of Fouqué and Michel Lévy were made by the slow cooling of mixtures from simple igneous fusion, and the question must here be raised how far these reactions would be affected by the intervention of water; in other words, whether, as maintained by Poulett Scrope, Scheerer, Elie de Beaumont, and many others, water is not always present in the mass of igneous rocks. So far as experiments go, the process of cooling from simple igneous fusion would seem to be inadequate to account for the origin of many of the minerals of eruptive rocks. Fouqué and Michel Lévy inform us that they "have vainly sought to produce, by igneous fusion, rocks with quartz, orthoclase, albite, white or black mica, or amphibole,"[1] although the occasional accidental production of orthoclase as a furnace-product has been noticed. The presence of albite in the recent lavas of Santorin, in association with labradorite, pyroxene, and chrysolite, has been shown by Fouqué (§ 32), and its probable occurrence in a diabase has been pointed out by Hawes.[2] Both orthoclase and albite have, however, been formed in the wet way, at elevated temperatures, under pressure; and pyroxene, while readily generated from the products of igneous fusion, was got by Daubrée by the action of superheated water on glass, at the same time with crystallized quartz and magnetite or spinel.[3] The frequent occurrence of pyroxene in veinstones, in intimate association with orthoclase, quartz, apatite, and calcite, suffices to show its aqueous origin, in common with all of these species. In like manner, magnetite, which is readily formed in fused basic mixtures, is found crystallized with orthoclase and quartz, with apatite and pyrite, in granitic veinstones. Moreover, the fact of its association with garnet, and with zeolitic minerals, in the secretions of basic rocks suffices to prove that magnetite, as well as hematite, may

[1] Synthèse des Minéraux et des Roches, p. 75.
[2] Trans. Roy. Soc. Canada, Vol. ii. Sec. iii. p. 39.
[3] *Ibid.*, p. 44.

be formed by aqueous action. Chrysolite also, is produced by igneous fusion, but its presence in crystalline limestone in the form of forsterite, and in massive magnetite as hortonolite, shows that, like the related and similarly associated chondrodite, it may be formed in the presence of water. [1]

§ 41. The evidences of the intervention of water in eruptive rocks have, since the time of Scrope, been too often pointed out to need repetition here. Its elements may even be retained in fused compounds at the temperature of ignition, under the ordinary atmospheric pressure, as seen not only in the hydrate and the acid sulphate of potassium, but in certain vitreous borates of sodium and potassium, long since described by Laurent, which at a red heat and in tranquil fusion hold an amount of hydrogen equal to 1.2 and 1.3 hundredths of water, and are, under these conditions, slowly decomposed by metallic iron, with abundant disengagement of hydrogen gas, which burns with a green flame from the presence of combined boron. [2] That, under greater pressure, water may be held by other compounds, such as silicates, is undoubted. Hydrous glasses like pitchstone and perlite are examples of these, and differ from obsidian in containing three or four hundredths of water.

§ 42. The late researches of Tilden and Shenstone on "The Solubility of Salts in Water at High Temperatures" throw much light on the geological relations of water. While the solvent power of this liquid rapidly increases, when under pressure, at temperatures above 100° C., they have shown that "the increase of solubility follows the order of the fusing-point of the solid." Thus, of potassium-iodid, which melts at 634°, 100 parts of water at 180° dissolve 327 parts, while of barium-chlorate, melting at 400°, 100 parts of water at 180° dissolve 526 parts. Of potassium-nitrate, melting at 339°, 100 parts of water at 120° dissolve 495 parts, or nearly five times its weight; while of silver-nitrate, whose fusing-point is 217°, 100 parts of water at 125° dissolve 1622.5 parts, and at 133° 1941.4 parts, or nearly twenty times its own weight. Of certain substances it can be said that they are infinitely soluble at certain temperatures. This is true of the decahydrated sodium-sulphate, which melts at 34°, and nearly true for benzoic acid. This substance, which melts at 120°, requires for its solution 600 parts of water at 0° and 25 parts at 100°; but when heated in a sealed tube to a few degrees above its fusing-point it is miscible with water in all proportions. These heated solutions, in the case at least of barium-chlorate and potassium-nitrate, are described as notably viscous, a condition which perhaps indicates that they are colloidal. [3]

§ 43. From these results it is easy to conceive what might be expected at elevated temperatures with materials as insoluble, at ordinary temperatures, as quartz or the natural silicates. A few hundredths of water at several hundred degrees Centigrade would probably convert these into a viscid fluid, from which, as from an anhydrous magma, by rest or by partial cooling, definite compounds might successively crystallize,—the mixture becoming, to use the simile of Poulett Scrope in speaking of lavas, like a syrup holding grains of sugar. From such mixtures partially cooled, or from a heterogeneous plutonic

[1] Trans. Roy. Soc. Canada, Vol. ii. Sec. iii. p. 61.

[2] The potassium-borate in question, apart from combined water, contained boric oxyd 58.6, potash 16.3, giving the oxygen-ratio 72 : 5; and the sodium-borate had the same atomic ratios. Aug. Laurent, Compte Rendu des Travaux de Chimie, 1850, pp. 36–42.

[3] Philos. Trans., 1884, Part i, pp. 23–36.

mass impregnated with water and not yet raised to the full temperature of solution, or what has been aptly termed "igneo-aqueous fusion," the more soluble portions, removed by percolation or by diffusion, we conceive to have constituted the liquids which in earlier times produced the various crenitic rocks. The fact that, as shown by Sorby,[1] pressure augments the solvent power of water, irrespective of temperature, should not be lost sight of in this connection. The remarkable observations of Tilden and Shenstone serve to explain and to justify the view of the intervention of water in giving liquidity to various eruptive rocks, originally put forward by Poulett Scrope, and afterwards ably maintained, among others, by Scheerer and Elie de Beaumont.[2]

The conversion of colloidal magmas, whether hydrous as just described, or anhydrous, as noticed in § 26, into denser crystalline species, not only involves the disengagement of heat, but as Becker has shown, its disengagement at a maximum rate, thus maintaining, with the temperature, the liquidity of the crystallizing magma.[3] The passage of certain dense species, as epidote, zoisite, garnet, beryl and quartz, when fused *per se*, into vitreous or crystalline forms of less specific gravity[4] is no exception to this law of condensation, since the chemical and physical conditions of the fused mass are unlike those of the more complex magma. When such a magma, holding combined a portion of water, is changed into anhydrous crystalline species, this will be liberated, as is shown in the often observed disengagement from solidifying lavas, of aqueous vapor, sometimes with boric oxyd, fluorhydric and chlorhydric acids, and various chlorids. Hence crystalline silicates like epidote, tourmaline, and micas, which contain these volatile elements, will only be generated under such conditions as prevent their liberation.

§ 44. We have already noticed the banded structure (§ 28) which often results from movement in the extrusion of more or less differentiated masses of eruptive rocks, simulating that produced by the separation from water either of mechanical sediments or of crystalline deposits. It is important in this connection to distinguish between the latter two processes, and to insist upon the more or less concretionary character of the matters separated from solution, often shown in the lenticular shape of beds of this character, and well displayed in the crystalline schists. The conditions under which these were laid down from water were less like those of ordinary sediments than of the accumulations of crystalline matter in geodes and in veins. Many facts with regard to the banded character of mineral veins are familiar to geologists, and the stratiform character of such deposits has often been remarked in smaller vein-like masses. I have elsewhere called attention to the fact that crystalline masses having the relations of veinstones may assume great proportions, and that much granitic rock often regarded as eruptive is in fact of concretionary and endogenous origin, discussing the question at some length in 1871.[5] Veins of this kind were then described sixty feet in breadth, traversing the gneisses and mica-schists of the younger gneissic or Montalban series, in New England, often coarsely crystalline

[1] Proc. Roy. Soc. London, xii. 538.

[2] Scrope, Jour. Geol. Soc. London, xii., 326; Scheerer, Bull. Soc. Geol. de France, 1845, iv. 468; and Elie de Beaumont, *Ibid.*, 1240 *et seq.* See farther the author's Chem. and Geol. Essays, 188–191, and also 5, 6, for farther references to the literature of the subject.

[3] Becker, Amer. Jour. Science, 1886, xxxi. 120.

[4] A Natural System of Mineralogy, etc. Trans. Roy. Soc. Can. Vol. iii. Sec. iii. p. 36.

[5] Granites and Granitic Veinstones, Amer. Jour. Science, 1871. Chem. and Geol. Essays, pp. 191-202.

and banded, and evidently concretionary, but sometimes so finely granular and homogeneous in portions as to be quarried for architectural purposes, like the indigenous gneisses of the series, which they often closely resemble. Remarkable examples of the same phenomenon are to be met with in the older gneissic or Laurentian series, some of which are conspicuous in the sections of these rocks visible in the cañon of the Arkansas River, and elsewhere in Colorado. Still more striking examples are met with in the similar gneisses in parts of Canada, and are well displayed in Ottawa county, in the province of Quebec, where, in the township of Buckingham, veins eighty feet in breadth, and made up almost wholly of orthoclase and crystalline cleavable magnetite, traverse for considerable distances the stratified gneiss of the region.[1]

§ 45. In the same county, and near the Rivière aux Lièvres, are the great veins which have lately been extensively mined for apatite in what is known as the Lièvres district. Very similar veins also occur a short distance to the southwest, along the Rideau canal, in the province of Ontario, in what may be called the Rideau district. The veins in this latter area were first described by the writer as early as 1848, and subsequently in 1863, in 1866, and in 1884.[2] The history of these apatite deposits in the two districts, which may be considered together, will serve to illustrate some important facts in the theory of crystalline rocks. The principal associates of the apatite in these districts are pyroxene, phlogopite, orthoclase, quartz, calcite, and pyrite. It was said of the localities in the Rideau district, in 1863, that a careful examination in each case shows that "the deposit occurs in a fissure in the stratification, and has well-defined walls," while "a banded arrangement of the mineral contents is often very well marked;" — the various minerals named sometimes occurring in alternate layers, of which the calcite, often with included apatite crystals, has "the aspect of a coarsely crystalline lamellar limestone." Farther examples were then given, showing the bilateral symmetry in many of the veins, and the occasional presence in them of drusy cavities. Moreover, although small portions of apatite were observed in what were regarded as the limestone beds of the enclosing gneiss, it was said that "the workable deposits of apatite, with few if any exceptions, are confined to the veinstones." Such were the conclusions announced by the writer as late as 1866. Subsequently, in 1884, after farther studies of the Rideau district, he was led to write that although the deposits of apatite are in great part in true veins cutting the strata, and sometimes including angular fragments of the wall-rock,—which is the characteristic red or gray gneiss of the country,—they are "in part bedded or interstratified in the pyroxene-rock of the region." With regard to certain apparently bedded deposits of apatite it was farther said, "I am disposed to look upon [them] as true beds, deposited at the same time with the enclosing rocks," which were described as "chiefly beds of pyroxene-rock, generally pale green or grayish-green in color, with mixtures containing quartz and orthoclase, and distinctly gneissoid in structure."

§ 46. I am careful to emphasize this apparent contradiction between the assertion of the truly endogenous character of the deposits in which apatite occurs with pyroxene,

[1] Geol. Report of Canada, 1863-66, pp. 20, 215.

[2] Geol. Survey of Canada, Report for 1848, p. 132, and for 1863-66, pp. 224-229; also Geology of Canada, 1863, pp. 461, 592, 761, and Trans. Amer. Inst. Mining Engineers, 1884, vol. xii, pp. 459-468. See farther, B. J. Harrington, Report Geol. Survey of Canada, 1877-78, G., pp 1-36, and J. Fraser Torrance, *Ibid.*, 1882-83-84, J., pp. 3-30, for valuable contributions to our knowledge of the Canadian apatite deposits.

phlogophite, orthoclase, quartz, and calcite, and that of the interstratification of the same apatite, in contemporaneous layers with a gneissoid pyroxenic rock, for the reason that both statements are strictly true, and that in their reconciliation light will be thrown on the great problem of the genesis of these crystalline aggregates. The mining operations on a large scale in these apatite deposits in the Lièvres district, especially in the years 1883–1885, have in fact shown that the stratiform pyroxenic masses are, like the associated orthoclase-rock, the apatite, and the calcite, subordinate parts of veins, which assume in many cases vast proportions, and at the same time have in parts of their mass a banded structure much resembling that of the enclosing gneiss. Illustrations of this condition of things abound at the great open cuttings for exploration and for mining which have been made at the High Rock, the Union, and the Emerald mines, in Portland and Buckingham townships, on the Lièvres River.[1] At the first-named locality the nearly vertical gray hornblendic gneiss, running northeast and southwest, is traversed by venous masses, sometimes with the strike, but at other times oblique or even at a right angle.

§ 47. A study of some of the smaller veins of the region (which are not mined) will help to an understanding of the nature and relations of those which are exploited for apatite. As seen at the High Rock mine, these lesser veins are from a few inches to several feet in width, and are chiefly of a binary granite or pegmatite, often including portions of the wall-rock, and sometimes, near their borders, presenting, for a breadth of two or three feet, a veritable breccia of angular fragments of gneiss from one to six inches in diameter. The granitic veinstone includes two feldspars, one weathering white and the other reddish, the latter forming considerable cleavable masses. A little white mica is also sometimes met with in these veins, which, in parts of their extension, hold portions of green cleavable pyroxene, sometimes in slender strings running with the strike, but in other cases filling the greater part of the vein, and including little seams of white feldspar, and small masses of greenish apatite,—fine and large crystals of which, and others of pyroxene, are, moreover, occasionally found directly imbedded in the granitic veinstone.

§ 48. Veins of vitreous quartz a foot or more in breadth are met with in the immediate vicinity, and also sometimes enclose crystals of apatite, or portions of feldspar, by an admixture of which they graduate into the binary granite or pegmatite. There is thus apparent a transition from pure quartz to a granitic rock, and to one essentially pyroxenic, each occasionally bearing apatite, which of itself also forms rock-masses. All of these are associated in the larger veins, in alternating bands or irregular lenticular masses sometimes a few inches in thickness, but at other times attaining breadths of many feet each. A frequent intermediate type of rock in these veinstones consists of a granular or coarsely cleavable green pyroxene with an admixture of quartz, and a feldspar, generally white in color, but occasionally bluish, and with cleavage-planes an inch in breadth. The quartz and feldspar in this aggregate sometimes predominate, offering a transition into the granitic rock already noticed, which frequently includes crystals of pyroxene.

[1] The workings at each of the three mines named have yielded five thousand tons or more of commercial apatite annually for three or four years, and consist for the most part of open cuttings, in some cases to depths of over one hundred feet, causing the uncovering or displacement of great portions of the accompanying rock-masses. In other mines in this region, also very productive, shafts have been sunk on apatite bands in these veins to depths of one hundred and fifty and two hundred feet.

apple-green or grass-green in color, and then sometimes holds clove-brown titanite, brown tourmaline, and, more rarely, zircon.

§ 49. These rocks, essentially made up of feldspar, quartz, and pyroxene, were long since noticed by the writer as occurring among the Laurentian gneisses in the Rideau district, and at various points in the province of Quebec, and were described in 1866 as generally "granitoid or gneissoid in structure, sometimes fine-grained, and at other times made up of crystalline elements from two tenths to five tenths of an inch in diameter. . . . They are often interstratified with beds of granitoid orthoclase gneiss, into which the quartzo-feldspathic pyroxenites pass by a gradual disappearance of the pyroxene." The occasional presence in them not only of titanite, but of mica, amphibole, epidote, magnetite, and graphite, was then noticed, and attention was called to the fact that these mineral species are common to the pyroxene rocks and to associated crystalline limestones. The feldspar of these intermediate rocks was described as having generally the characters of orthoclase, as was shown by the analysis of a specimen from Chatham, Quebec, but as, in some cases, triclinic and resembling oligoclase.[1] Dr. Harrington has since found for one of these the composition of albite.

As will appear from the language just cited, these aggregates were then regarded as portions of the country-rock. The pyroxenite seen in North Burgess, in the Rideau district, was described as sometimes granitoid, and at other times micaceous and schistose, interstratified with what was then called a binary granitoid gneiss, and also with layers of crystalline limestone, some of them holding serpentine, and others including pyroxene, mica, and crystals of apatite. Both varieties of the pyroxenic rock were then said to contain small grains and masses of apatite, in one case forming an interrupted bed, which was traced two hundred and fifty feet with the strike, and was in parts two feet in thickness.

§ 50. While apatite was thus found in crystals, in lenticular masses, and in layers, alike in the calcareous and the pyroxenic stratiform rocks, these same rocks were described as traversed at right angles by veins, the banded and symmetrical character of which was insisted upon, carrying not only apatite but calcite, quartz, orthoclase, scapolite, pyroxene, amphibole, and wollastonite. While the venous character of these secondary deposits (which also intersect the red and gray gneissic country-rock) was thus recognized, it was not until a later period that it became apparent that the same view was to be extended to the greater stratiform masses in which these veins were enclosed; in fact that the process of depositing these mineral species had been repeated in these localities, and that the pyroxenic and granitic rocks, not less than the interstratified limestone masses, were portions of great endogenous masses or lodes.[2]

§ 51. At this stage of the inquiry the writer found himself face to face with the exoplutonists. Emmons, who, in 1842, first described the geological characters of the similar crystalline rocks in northern New York, regarded the whole of them—gneisses, granites, iron-ores, and crystalline limestones included — as of plutonic origin, a view which was supported by the evident geognostic relations of the calcareous veins. This was in accordance with the views of Von Leonhard, Savi, and others in Europe, who

[1] Geology of Canada, 1863, p. 475; also Report Geol. Survey of Canada, 1863-66, pp. 185 and 224-228.

[2] For an analysis of the argument, and many references, see Amer. Jour. Science, 1872, iii. 125, and Chem. and Geol. Essays, p. 208.

taught the igneous origin of certain limestones—an opinion afterwards adopted by J. D. Dana, who supposed that some of the so-called primary limestones "were of igneous origin, like granite." The aqueous origin of similar calcareous masses in Scandinavia had, however, been recognized by Scheerer and by Daubrée, and in Germany by Bischof; while the vein-like character of certain aggregates of this kind, in which various silicates and other mineral species are associated with carbonate of lime in the ancient gneisses of North America, had been noticed by C. U. Shepard, H. D. Rogers, and W. P. Blake, among others, as was shown by the writer in some detail, in 1866. In a paper then read before the American Association for the Advancement of Science, it was said that deposits of carbonate of lime, sometimes of great dimensions, and holding the characteristic minerals of the crystalline limestones, are found filling fissures and veins in the Laurentian gneisses. These were then designated endogenous rocks, regarded as of aqueous origin, and to be carefully distinguished from intrusive or exotic rocks.[1]

The subject was discussed in the same year in an account of the mineralogy of the Laurentian rocks, when it was said, in commenting upon the view of Emmons that such masses, and in fact all of the crystalline limestones of the series, are eruptive: — "The greater part of the calcareous rocks in the Laurentian system in North America are stratified, and the so-called eruptive limestones are really calcareous veinstones or endogenous rocks, generally including foreign minerals, such as pyroxene, scapolite, orthoclase, quartz, etc."[2] I had not at that time as yet discovered that these same endogenous masses may include, besides calcareous bands, others essentially quartzose, pyroxenic, and feldspathic, resembling more or less the strata of the enclosing gneissic series, nor considered that these same calcareous bands might sometimes be found in fissures coincident with the bedding of the latter.

§ 52. In 1869 I visited with the late L. S. Burbank a locality at Chelmsford, Massachusetts, where limestone has been quarried from interrupted masses, sometimes two hundred feet in length, enclosed in gneisses of the ordinary Laurentian type, to which I then referred them.[3] I failed to recognize in the quarries then examined the endogenous character which doubtless belongs to some of the limestone-masses of this region, where they have been traced, at intervals, for twenty-five miles, through Chelmsford, Boxborough, and Bolton; but at the same time I called the attention of Mr. Burbank to the question of these vein-like masses, placing in his hands my publications of 1866. He, as a result of farther observations, had, in 1871, persuaded himself that all of the limestones of the region were newer than the enclosing rocks, not eruptive, but "of a vein-like character," occupying fissures in the gneiss, of which character his descriptions, in certain cases, give evidence.[4] He noted the banded structure visible in the arrangement of the various enclosed minerals, as I had described them in 1866 in the similar limestone-masses in Canada, and enumerated in the region under consideration: amphibole, pyroxene, chrysolite (forsterite or so-called boltonite), phlogopite, scapolite, and garnet, besides serpentine, in grains or in irregular bands or layers, sometimes traversed by veins of chrysotile. To this list may be added spinel, chondrodite, petalite, and titanite.

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[1] Proc. Amer. Assoc. Adv. Science, 1866, p. 54; also Can. Naturalist (II.) iii. 123.

[2] Report Geol. Survey of Canada, 1863-66, p. 194. See also the facts resumed in Chem. and Geol. Essays, p. 218.

[3] Amer. Jour. Science, 1870, xlix. 75.

[4] Burbank. Proc. Amer. Assoc. Adv. Science, 1871, pp. 263-266.

§ 53. The late J. B. Perry at the same time and place[1] announced a similar conclusion, to which he had arrived, namely, that these limestones in eastern Massachusetts, as well as others elsewhere in New England and in northern New York, though possessing "the form of dikes," "have a vein-like structure, and should be regarded as true vein-stones." He farther says of these deposits: "The foliated structure, with its accompanying series of mineral substances, each occurring in a determinate order, evinces that the process of deposition was gradual and probably long continued." Thus these observers, in 1871, had, although without acknowledgment, confirmed my observations and adopted my conclusions of 1866 as to these endogenous calcareous masses of the ancient gneissic series. J. W. Dawson had in 1869 recognized *Eozoon Canadense* in a serpentinic limestone from Chelmsford, and both Burbank and Perry maintained that all of the limestone masses of the region were vein-stones, as an argument against the organic nature of Eozoon.

§ 54. The mineralogy of these endogenous, more or less calcareous, masses has been the subject of much study. While sometimes having the aspect of a coarsely crystalline limestone, and nearly pure, they may include apatite, fluorite, chondrodite, wollastonite, amphibole, pyroxene, danburite, serpentine, phlogopite, gieseckite, orthoclase, scapolites, brown tourmaline, idocrase, prehnite, epidote, allanite, garnet (sometimes chromiferous), titanite, zircon, rutile, spinel, völcknerite, corundum, menaccanite, magnetite, hematite, pyrite, and, more rarely, pyrrhotite, chalcopyrite, sphalerite, molybdenite, and galenite. To these must be added stilbite, chabazite, and barite. All of these species have been met with in the deposits studied in Canada and New York, while in the similar calcareous masses in eastern Massachusetts chrysolite and petalite occur. Exceptionally, as in Franklin and Stirling, New Jersey, there are found in this connection zinciferous and manganiferous minerals, as willemite, tephroite, spartalite and franklinite.[2]

The various associations of apatite in these aggregates are worthy of notice. Crystals of this species have been observed by the writer directly imbedded in the quartzo-feldspathic vein-stone, in vitreous quartz, in calcite and dolomite, in pyroxene, in crystals of phlogopite, in pyrite, in magnetite, in spinel, and in foliated graphite, as well as in a massive granular apatite, which sometimes surrounds large and well defined crystals of the same species. Dr. Harrington has farther noted its inclusion in amphibole, in orthoclase, in scapolite, in steatite, and in fluorite. On the other hand, apatite crystals have been found to enclose quartz, calcite, fluorite, phlogopite, pyroxene, zircon, titanite, and pyrite. The apatite of these deposits, so far as known, is essentially a fluor-apatite, containing in one case, by the writer's analysis, 0.5 hundredths of chlorine. From these facts it is evident that the succession of species in these veins is by no means invariable. Mention should here be made of the apatite occurring in disseminated grains in the great deposit of magnetite so extensively mined at Mount Moriah, near Port Henry, New York. The banded arrangement of the crystalline apatite, generally reddish in color, and in thin

[1] Perry. Proc. Amer. Assoc. Adv. Science, 1871, pp. 270-276.

[2] For farther and more detailed accounts of the occurrence of the mineral species already mentioned, and many others which are found with the calcarous masses of the Laurentian rocks, see Report Geol. Survey of Canada, 1863-66, pp. 181-229, which were reprinted, with the exception of the last six pages, in the Report of the Regents of the University of New York, for 1867, Appendix E. See also, in abstract, Chem. and Geol. Essays, pp. 208-217, and farther the reports of Dr. Harrington and Mr. J. Fraser Torrance, cited in the note § 45.

layers, occasionally predominating, gives a stratified aspect to the iron ore. A similar aggregate is found in the Rideau district, in Ontario.

§ 55. The stratiform character of these endogenous deposits, as seen alike in the individual portions, and in the arrangement of these as constituent parts of a vein, is well shown at the Union mine, in the Lièvres district. Here the great mass or lode is seen to be bounded on the west by a dark-colored amphibolic gneiss, nearly vertical in attitude, and with a northwest strike. Within the vein, and near its western border, is enclosed a fragment of the gneiss, about twenty feet in width, which is traced some yards along the strike of the vein, to a cliff, where it is lost from sight, its breadth being previously much diminished. It is a sharply broken mass of gray banded gneiss, with a reentering angle, and its close contact with the surrounding and adherent coarsely granular pyroxenic vein-stone is very distinct. Smaller masses of the same gneiss are also seen in the vein, which was observed for a breadth of about 150 feet across its strike,—nearly coincident with that of the adjacent gneiss,—and beyond was limited to the northeast by a considerable breadth of the same country-rock.

§ 56. In one opening on this lode there are seen, in a section of forty feet of the banded veinstone, repeated layers of apatite, pyroxenite, and a granitoid quartzo-feldspathic rock, including portions of dark brown foliated pyroxene, all three of these being unlike anything in the enclosing gneiss, but so distinctly banded as to be readily taken for country-rock by those not apprised of the venous character of the mass. A fracture, with a lateral displacement of two or three feet, is occupied by a granitic vein twelve inches wide, made up of quartz with two feldspars and black amphibole, which themselves present a distinctly banded arrangement. This same granitic vein is traced for fifty feet, cutting obliquely across both the pyroxenite and the older granitoid rock, and at length spreads out, and is confounded with a granitic mass interbedded in the greater vein. It is thus posterior alike to the older quartzo-feldspathic rock, the pyroxenite, and the apatite,—as are also many smaller quartzo-feldspathic veins, which, both here and in other localities in this region, intersect at various angles the apatite, the pyroxenite, and the granitoid rock into which the latter graduates. We have thus included in these great apatite-bearing lodes, quartzo-feldspathic rocks of at least two ages, both younger than the enclosing gneiss. A small vertical vein of fine-grained black diabase-like rock intersects the whole. No one looking for the first time at this section of forty feet, as exposed in the quarry, with its distinctly banded and alternating layers of pyroxenite and granitoid quartzo-feldspathic rock, including two larger and several smaller layers of crystalline apatite, would question the stratiform character of the mass, whose venous and endogenous nature is, nevertheless, distinctly apparent on farther study.

In other portions of the same great vein, which has been quarried at many points, this regularity of arrangement is less evident. Occasionally masses are met with presenting a concretionary structure, and consisting of rounded or oval aggregates of orthoclase and quartz, with small crystals of pyroxene around and between them; the arrangement of the elements presenting a radiated and zone-like structure, and recalling the orbicular diorite of Corsica. The diameter of these granitic concretions varies from half an inch to one and two inches, and they have been seen in several localities in the veins of this region, over areas of many square feet.

§ 57. In the Emerald mine the stratiform arrangement in the vein is remarkably

displayed. Here, in the midst of a great breadth of apatite, were seen two parallel bands (since removed in mining) of pyroxenic rock, several yards in length, running with the strike of the vein, and in their broadest parts three and eight feet wide, respectively, but becoming attenuated at either end, and disappearing, one after the other, in length, as they did also in depth. These included vertical layers, evidently of contemporaneous origin with the enclosing apatite, were themselves banded with green and white from alternations of pyroxene and of feldspar with quartz. Accompanying the apatite in this mine are also bands and irregular masses of flesh-red calcite, sometimes two or three feet in breadth, including crystals of apatite and others of dark green amphibole. Elsewhere, as at the High Rock mine, tremolite is met with. In portions of the vein at the Emerald mine, pyrite is found in considerable quantity, and occasionally forms layers many inches in thickness, sometimes with pyrrhotite. Several large parallel bands of apatite here occur, with intervening layers of pyroxenic and feldspathic rock, across a breadth of at least 250 feet of vein-stone, besides numerous small, irregular, lenticular masses of apatite. The pyroxenite in this lode, as elsewhere, includes in places large crystals of phlogopite, and also presents in drusy cavities crystals of a scapolite, and occasionally small brilliant crystals of colorless chabazite, which are implanted on quartz.

At the Little Rapids mine, not far from the last, where well defined bands or layers of apatite, often eight or ten feet wide, have been followed for considerable distances along the strike, and in one place to more than 200 feet in depth, these are, nevertheless, seen to be subordinate to one great vein, similar in composition to those just described, and including bands of granular quartz. In some portions of this lode the alternations of granular pyroxenite, quartzite, and a quartzo-feldspathic rock, with little lenticular masses of apatite, are repeated two or three times in a breadth of twelve inches.

§ 58. The whole of the observations thus set forth in detail above, serve to show the existence in the midst of a more ancient gneissic series, of great deposits, stratiform in character, complex and varied in composition, and, though distinct therefrom, lithologically somewhat similar to the enclosing gneiss. Their relation to the latter, however, as shown by the outlines at the surfaces of contact, by the included masses of the wall-rock, the alternations of unlike mineral aggregates, the evidences of successive and alternate deposition of mineral species, and the occasional unfilled cavities lined with crystals, forbid us to entertain the notion that they have been filled by igneous injection, as conceived by plutonists, and lead to the conclusion that they have been gradually deposited from aqueous solutions. This conclusion is made more apparent when we compare these immense banded lodes with the many small veins from a foot in breadth upwards, also banded, and lithologically similar to the great lodes, which intersect not only these but the ancient gneisses, as already described at the High Rock mine, and also in many other localities, especially in parts of the Rideau district.

It may here be noticed that the very similar banded and vein-like deposits now largely mined for apatite in Norway, are regarded by Brögger and Reusch, who have lately studied them, as igneous masses irrupted in a liquid condition, and slowly cooled from fusion,—an hypothesis by which they endeavor to explain many of the phenomena of these deposits. For an analysis of their argument, and a forcible statement of the objections thereto, the reader may consult Dr. Harrington's report on the apatite region of the Lièvres. [1]

[1] Brögger and Reusch. Zeitschrift d. deutsch. Geol. Gesell. Heft iii. pp. 646-702. Report Geol. Survey Canada, 1877-78, G., pp. 11-12.

§ 59. These various endogenous deposits are instructive illustrations of the crenitic process. The alternations of stratiform layers of quartz, of calcite, and of feldspathic and pyroxenic aggregates, with included layers of apatite, pyrite, etc., show that a process closely analogous to that which formed the older gneissic series was in operation, and gave rise to these banded mineral masses in the midst of rifted and broken strata of the older rocks after these had assumed their present attitude. The lithological resemblances between the older and the younger deposits are not less remarkable than their differences, and suffice to show the great similarity between the conditions which produced the vein-stones and their enclosing rocks. The latter, however, appear, in the present state of our knowledge, to have been deposited not only on a vaster scale but apparently in a horizontal or nearly horizontal attitude.

§ 60. What are regarded as examples of calcareous deposits of the two ages were described by the writer, in 1878, as occurring at Port Henry, on Lake Champlain, in the State of New York. Near the town is a quarry whence limestone has been got for the blast-furnaces of the locality. "Here elongated, irregular fragments of dark hornblendic gneiss, from two inches to a foot in thickness, were found completely enveloped in crystalline carbonate of lime. In 1877, five such masses of gneiss were exposed in an area of a few square yards. One of these, a thin plate of the gneiss, having been broken in two, the enclosing calcareous matter had filled the little crevice, keeping the fragments very nearly in their place. The carbonate of lime, which is coarsely granular, and contains some graphite and pyrite, is banded with lighter and darker shades of color, and one of its layers was marked by the presence of crystals of green pyroxene and of brown sphene. The contact of this mass with the surrounding gneiss, which is near by, is concealed. No serpentine was found in this limestone, though it abounds in a limestone quarried in the vicinity. About half a mile to the north is still another quarry, opened in a great and unknown breadth of more finely granular and somewhat graphitic limestone, which near its border presents three beds of two or three feet each, interstratified with the enclosing gneiss." Of this it was said that "it presents alternations of lighter feldspathic and darker hornblendic beds, with others highly quartzose, and includes layers of a sulphurous magnetite, which are, however, insignificant when compared with the great deposit of this ore mined at Mount Moriah, in the vicinity."

§ 61. While the great breadth of limestone interstratified with the gneiss was regarded as belonging to the ancient series, it was said of the limestone of the first-described quarry, that it "seems clearly to be a brecciated calcareous vein enclosing fragments of the gneiss wall-rock.[1] Reference was then made to similar observations in this vicinity described by Prof. James Hall in 1876, who, from this breccia of gneiss-fragments in an exposure to crystalline limestone, rightly inferred the posterior deposition of the latter, and was led to conjecture that it might belong to a newer geological series. The only evidence of this, however, was the enclosed fragments of the gneiss, which, in similar cases, had led Emmons and Mather to infer the eruptive character of these same limestones, regarded by the writer as endogenous masses or vein-stones. The great thickness of the interstratified limestone-masses which form, according to Logan, integral parts of the vast Laurentian series, and their geographical extent, were described in detail in the

[1] Azoic Rocks, etc., pp. 166-167; also the Geology of Port Henry, Canadian Naturalist, x, No. 7.

publications of the Geological Survey of Canada, in 1863, and farther in 1866. A summary of these results will be found in the writer's volume on Azoic Rocks, page 154.

§ 62. As regards the genesis, according to the crenitic hypothesis, of the various mineral species found in this vast crystalline series, alike in the more ancient strata and in their included endogenous masses, we have already considered the formation of the double silicates of alumina with alkalies and lime, represented by the various feldspars, and more rarely by the scapolites, epidote, garnet, and the muscovitic or non-magnesian micas. These latter, though abundant, with garnet and black tourmaline, in some granitic veins in this geological series, are rare in those portions in which the protoxyd-silicates abound; while the silicates of alumina without protoxyd-bases, such as are andalusite, fibrolite, cyanite, topaz, and pyrophyllite, are unknown. On the other hand, aluminous double silicates with magnesia are abundantly represented by phlogopite, and protoxyd-silicates with magnesia, such as chondrodite, pyroxene, and amphibole, are abundant; the simple calcareous silicate, wollastonite, being more rarely met with. The genesis of all these we have supposed to be by the reaction of soluble calcareous silicates with magnesian and ferrous solutions. The magnesia required may be found either in salts like those of sea-water, or in solutions of magnesian bicarbonate from subaerial decay of plutonic rocks, which solutions, by reaction with lime-silicates, would give rise to insoluble magnesian compounds and soluble lime-carbonate. A similar reaction, with liberation of silica, would result from the direct operation of carbonic-dioxyd upon the lime-silicate. The intervention of ferrous solutions in similar reactions has already been discussed in considering the origin of glauconite, in § 10–12.

§ 63. As regards the presence in these, and similar crystalline rocks, of basic oxyds uncombined with silica or with carbonic acid, such as alumina and magnesia in corundum; spinel and some chromites; chromic oxyd in the latter and in some spinels; glucina and magnesia in chrysoberyl and periclase; together with zinc, manganese and iron-oxyds in spartalite, franklinite, magnetite, and hematite; not to mention titanic oxyd in rutile, and in menaccanite and other titanates,—it should be noticed that these various compounds for the most part occur in such intimate association with certain silicates as to suggest their contemporaneous production. Thus corundum and spinel are found crystallized with certain micas, with chlorites, or with feldspars, pyroxene or chrysolite, in which latter, or in serpentine, chromite is generally met with. Spartalite and franklinite are associated with silicates of zinc and manganese, and magnetite with quartz, with orthoclase, with pyroxene, with chondrodite, or with chrysolite; while rutile and menaccanite are found in like manner with feldspars, with phlogopite, or with serpentine. The intimate association of magnetite with calcite, with apatite, with pyrite, and with graphite, in these deposits, may also be noticed. We must conclude that all these simple and compound oxyds have been in solution, and have crystallized in the presence of the various silicates, etc., and in many cases with quartz. It is evident that the partial reduction and solution of ferrous oxyd by the intervention of the products of organic decay, and its subsequent precipitation, which in later times, has played so large a part in the genesis of iron-oxyds and carbonate, is not the sole agency. A process which separates not only iron-oxyd, but chrome-oxyd, alumina, glucina, magnesia, and zinc and manganese-oxyds from their silicated combinations, and has permitted them to crystallize side by side with silicates, and even with free silica, has intervened in the genesis of these ancient crenitic

deposits. The solvent action exerted by solutions of alkaline silicates on oxyds of iron, manganese, zinc, magnesium, and calcium, as well as upon those of tin, antimony, copper, and mercury, throws, as elsewhere pointed out, an important light on this problem.[1]

To this we must add the dissociation of silicate of alumina at elevated temperatures, under pressure, in presence of alkaline solutions, with separation of silica in the form of quartz, as observed by Daubrée and Henri Sainte-Claire Deville[2]. These experimenters obtained at the same time zeolites, and one of them pyroxene, apparently with magnetite; while Friedel and Sarresin, under similar conditions, got orthoclase and albite, quartz and analcite. We are as yet ignorant under what circumstances the liberated alumina might be separated from these solutions as corundum or diaspore. The conditions of temperature, and the presence of alkaline solutions in these experiments, approach very closely to those which we have supposed to concur in the formation of mineral species by the crenitic process.

§ 64. The geognostic and genetic history of the great endogenous crystalline masses which we have now discussed in some detail is important for several reasons: 1. It brings before us the views of the plutonists, who see in great bodies of crystalline limestone, and of magnetite, as well as in granitic veins and in metalliferous quartz lodes, the evidences of igneous eruption. 2. It shows the differences, alike mineralogic and geognostic, between true exotic rocks (which, with small differences in composition, have been erupted through widely separated geologic ages up to the present) and those endogenous deposits which are found only in eozoic rocks, and were formed in eozoic time, since their fragments are met with in the oldest overlying palæozoic sediments. 3. It makes evident the close mineralogic resemblances between these endogenous crystalline masses and the more ancient enclosing rocks, and thus helps us to a clearer conception of the conditions under which these ancient gneissic strata, and the pre-gneissic granite itself, were alike generated.

§ 65. The crenitic hypothesis, as we have seen, supposes that the granite, and the succeeding crystalline schists, have been built up by matters dissolved from a primary plutonic substratum, upon which, as upon a floor, through successive ages, was laid down the enormous thickness of crenitic rocks, which, with small exceptions, make up the pre-Cambrian terranes. The bearing of this hypothesis upon the great problem presented by the corrugated condition of the older crystalline schists has already been noticed in a previous essay.[3] The contraction of a cooling globe, which is often cited in explanation of this phenomenon, is clearly inadequate to account for this great and general corrugation of the strata, and the present writer in 1860[4] suggested, as a farther element in the explanation thereof, the condensation during crystallization of the mechanical sediments from which, in accordance with the Huttonian hypothesis, the crystalline schists were supposed to be derived. This explanation, based on an untenable hypothesis, must, however, be rejected. The endoplutonist must appeal to contraction in the igneous mass of the globe as the only explanation of the corrugations of its outer envelope, while the exoplutonist adds thereto the diminution of the liquid interior as the result of successive transfers of portions of its mass by ejection of igneous material from beneath a first-formed

[1] Trans. Roy. Soc Can., Vol. ii. Sec. iii. pp. 45 and 61.

[2] *Ibid.*, Vol. ii. Sec. iii. p. 49.

[3] *Ibid.*, Vol. ii. Sec. iii. p. 60.

[4] Amer. Jour. Science, xxx. 138, and Chem. and Geol. Essays, pp. 46, 71.

crust. Against this latter explanation it is to be urged that, as we have endeavored to show, the successive groups of stratiform crystalline rocks which have been laid down on the pre-gneissic granite, and even this primeval granite itself, are not igneous but aqueous in origin, so that the exoplutonic hypothesis itself is untenable. The amount of plutonic extravasation in pre-Cambrian times was apparently small.

§ 66. The crenitic hypothesis, however, admits a transfer of matters from below upward, in a state of solution, and the building-up from them, upon the solid floor of igneous rock, of the granite and all the succeeding crystalline schists, as in the scheme of the exoplutonists. This new aqueous hypothesis thus offers, it is believed, for the first time, a reasonable and tenable explanation of the universal corrugation of the oldest crystalline strata. The earth, according to this hypothesis, although intensely heated, had not, even at the early time when the waters were first condensed on its surface, a liquid interior, but was solid; and its crust is supposed to have presented no variations in composition, except such as might result from crystallization and eliquation in a purely igneous congealing mass. The superficial quartzo-feldspathic or granitic layer, which is believed to overlie everywhere the quartzless basic doleritic rock, did not then exist, but has since been derived by crenitic action from the primary plutonic layer. This granitic stratum is, however, itself still subject, like the basic stratum beneath, to softening under the combined influences of water and heat, and to extrusion in the forms of eruptive granite and trachyte; although it is less fusible, and, consequently, less susceptible of differentiation by eliquation. It is, moreover, at the same time, less liable to alteration by lixiviation, from the fact that it is not a mass cooled from igneous fusion, but one deposited from water at comparatively low temperatures, and thus lacks the porosity which belongs to the original plutonic stratum.

§ 67. The upward transference of the vast and unknown quantity of material constituting the ancient granitic and gneissic rocks, which are at least many miles in thickness, and the contraction of the plutonic substratum, diminished by the removal of this great mass, would necessarily result in great movements of subsidence, with plications and fractures of the gneissic strata. We are, of course, ignorant whether these processes went on to a uniform degree over the whole surface of the earth, and whether similar conditions of thickness, and similar corrugations exist in those great portions of the eozoic crust which are concealed beneath the ocean's waters, and beneath accumulations of newer strata. It may well be that the plication of the ancient granitic crust was, as in the case of younger stratified rocks, limited to certain areas. It can only be affirmed, in the present state of our knowledge, that in the relatively very small areas of the oldest gneissic rocks known to us, this plication is great and apparently universal, diminishing, however, materially in degree in the younger gneissic series.

§ 68. Within the fractures and rifts of the ancient gneissic strata resulting from these great movements, the products of the uninterrupted crenitic process would henceforth be deposited, filling them with masses closely resembling those of the enclosing strata. Repetitions on a smaller scale of those movements would give rise to newer fissures intersecting alike these strata and the first-deposited vein-stones, in the manner shown in our studies of the Laurentian rocks, where the process which produced the original quartzose, feldspathic, and calcareous deposits of the series was repeated at least twice, giving rise to primary and to secondary vein-stones mineralogically very similar to the first-formed or

country-rock, and thereby showing the survival of the original chemical conditions of solution and deposition after one, and even after two, movements of displacement and disruption in the region.

§ 69. We have thus endeavored in the present essay to bring together, in the first place, a number of facts which serve to throw light upon the generation of mineral silicates by aqueous processes, especially in later times, subsequent to the formation of the great series of crystalline schists, and thereby help to a better understanding of the crenitic hypothesis. We have next considered the two plutonic hypotheses as to the origin of crystalline rocks, and have discussed the question of stratiform structure in rocks whose eruptive character is undisputed. This has led us to consider the process of differentiation in such masses through partial crystallization and eliquation, and, farther, to a discussion of the possible relations of water to the process. The secular changes which may be wrought in igneous masses by aqueous percolation were next discussed, with reference at the same time to the crenitic process. From this we were led to a discussion of the stratiform structure seen in vein-like masses for which an igneous origin is inadmissible, and which, it is maintained, are endogenous deposits of crenitic origin. An account of these, as they have been observed in the ancient gneissic rocks of North America, leads to a farther consideration of the crenitic hypothesis, alike in relation to the genesis of the silicates, carbonates, and non-silicated oxides of the crystalline rocks, and also to the general plication of the ancient crystalline strata.

§ 70. The conclusions from this extended study are, briefly, as follows: The quartzless basic material which is supposed to have constituted the primary plutonic mass, and is the direct source of basaltic and doleritic rocks, has been subject to modifications from three agencies:—

1. The solvent action of permeating and circulating waters, which, from parts of it, have removed alumina, with preponderating proportions of silica and potash,—the elements of granitic, trachytic, and gneissic rocks,—and also silicates of alumina and other protoxyds, which have been more or less directly the source of the other silicated species of the oxyds, and in part also of the carbonates of the crystalline schists and veinstones.

2. The farther action of the same circulating waters in carrying down from the surface, alike in the condition of carbonates, formed by subaerial action, and of sulphates and chlorids, large portions of calcium, magnesium, sodium, and potassium, all of which, by interchange and replacement, have variously modified the composition of the plutonic material.

3. The process of differentiation in portions of the plutonic mass by partial crystallization and eliquation, thereby giving rise to more chrysolitic and more pyroxenic aggregates on the one hand, and to more feldspathic aggregates on the other,—a process in which it is conceived water may intervene, giving to the material an igneo-aqueous fluidity.

All of these agencies, it is believed, have, from the earlier ages, been at work on the plutonic substratum, causing secular changes alike in the crenitic products derived therefrom, and in the residual portion, from which have come, and are still derived, the basic eruptive rocks.

III.—*On the Colouring Matter of Black Tourmalines.*

By E. J. CHAPMAN, PH.D., LL.D.

(Read May 27, 1886.)

The subspecies of tourmaline, commonly known as "Schorl", presents a deep-black colour, combined with perfect opacity. Typical examples, even in fine splinters and on the thinnest edges, are completely opaque. To what is this black, opaque condition due?

As shown by numerous analyses, and notably by those of Gmelin, Mitscherlich and Rammelsberg, the only glass-colouring elements present in tourmaline are iron and manganese. Most of the older analyses, as those of Gmelin, as well as the still earlier determinations of Klaproth and others, assume the iron to be present in the condition of ferro-ferric oxide, $Fe^3 O^4$, and the manganese in that of manganic oxide, $Mn^2 O^3$. In the analyses of Arfvedson and Gruner, made at about the same date as those of Gmelin, both metals are regarded as sesquioxides; whilst in the comparatively modern analyses of Mitscherlich and Rammelsberg they are asserted to be present as monoxides (Fe O and Mn O). The facts and deductions brought forward in this attempt to trace out the colouring matter of shorl and the darker tourmalines, will shew, I think, that the older view regarding the condition of the iron in these minerals is really the correct one.

Manganic oxide, it is well known, constitutes an intensely colouring matter as regards vitreous compounds. The finer black beads and "bugles," for example, are coloured entirely by about 10 or 12 per cent. of that oxide, the presence of a little boric acid apparently intensifying the reaction. But, as regards black tourmaline, manganese may be left out of consideration, because its amount, whether present as $Mn^2 O^3$ or otherwise, is altogether insufficient to produce the black colour and opacity of the mineral. Many, if not most, varieties of schorl shew, under blowpipe treatment with sodium carbonate and nitre, a very faint manganese reaction; and the amount of manganese in green and red transparent or translucent tourmalines is higher, as a rule, than in black tourmalines. Hence the black colour cannot arise from the presence of manganese. Neither can it be due to any compounds of titanium, uranium, etc., the absence of these being fully proved by analysis.

It is to the iron, therefore, that we must evidently look as the source of this black colour and opacity,—unless the color be regarded as due to the presence of carbon or carbonaceous matters, or to the problematical existence of a black allotropic condition of the silica or other component present in the mineral.

Carbonaceous matter, we know, is frequently present in examples of quartz, obsidian, etc.; but this burns off more or less readily during ignition, while black tourmaline, even in fine powder, exposed to prolonged ignition in the muffle, retains its black colour, or assumes merely a brownish tint upon the surface.

The existence of a black allotropic condition of silica (or of any of the other components of these dark tourmalines) is a very gratuitous supposition; especially when we consider that where a silicate, as amphibole, pyroxene, epidote, garnet, etc., presents several varieties or subspecies differing in intensity of colour, the dark kinds always contain a certain amount of iron, whilst the lighter varieties are often entirely free from ferruginous matter.

All things considered, therefore, there can be little doubt that the black colour and opacity of schorl is due to the presence of iron in some state of oxidation. The question is, in what state? Rammelsberg's analyses might be thought a sufficient answer; but with all due recognition of the high place deservedly occupied by this chemist as a mineral investigator, there are certain facts which are altogether opposed to the acceptance of his view that all the iron in black tourmaline is in the condition of monoxide. Neither $Fe\,O$ nor $Fe^2\,O^3$, when completely dissolved in a vitreous flux, produces blackness and opacity. As first clearly shewn by Berzelius, $Fe^2\,O^3$ in a borax glass—and the reaction is the same in a fusible siliceous glass—imparts to this a yellowish tint. On partial reduction, when the $Fe^2\,O^3$ becomes $Fe^3\,O^4$, the glass becomes bottle-green; and with excess of oxide it turns black and opaque. But on complete reduction to $Fe\,O$ (not easily effected when much colouring matter is present) the blackness and opacity give place to a clear green colour, and the glass becomes more or less transparent. In connection with these reactions, one may call to mind the oxidizing effect, and its results, of nitric acid on a crystal of ferrous sulphate: the blackening of the crystal at first, and the subsequent decoloration on the oxidation becoming complete. In one case the deep color results from the reduction of $Fe^2\,O^3$ into $Fe^3\,O^4$; and in the other, from the oxidation of $Fe\,O$ into the latter compound. In both cases the blackness or depth of colour is produced not by $Fe\,O$, nor by $Fe^2\,O^3$, but by $Fe^3\,O^4$.

From these considerations, therefore, supported by the experiments described below, I think it may be fairly inferred that the iron in the black and deeply-coloured tourmalines is wholly or essentially present as ferro-ferric oxide.

It might be thought that if the black tourmalines contain $Fe^3\,O^4$ they should be attractable in small splinters by an ordinary magnet, whereas they do not show this character; but when a borax-glass, or a boro-siliceous glass, is rendered black before the blow-pipe, by excess of ferro-ferric oxide, it does not, even in splinters, show any magnetic attraction.

The following experiments (the products resulting from which I have the honour to lay before the Society) go far to support the view advocated in this paper, namely, that the iron in black tourmaline, from which the colour of the mineral is derived, is essentially in the condition of ferro-ferric, not of ferrous, oxide.

(1) A portion of a large, intensely-black crystal of tourmaline was subjected, in an open crucible, to a strong heat for a couple of hours. It melted, and became slightly brown on the surface. When broken, it showed internally a vesicular structure, and dull black colour. Portions of other black crystals treated in this manner gave similar results. A slight peroxidation of the surface only was effected. The dark colour practically remained unchanged.

(2) Another portion of the large crystal, used in experiment No. 1 was imbedded in a thick mass of filings of black pig-iron in an ordinary clay crucible. Powdered anthracite

was then filled in nearly to the top of the crucible, and the latter, covered with its lid, was kept for a couple of hours at a strong heat in a powerful gas furnace. The iron filings became agglutinated, and the tourmaline, transformed into a highly vesicular mass, was almost completely decolourised. The coal at the top of the mixture remained unchanged until the lid was removed, when combustion of course ensued. A small piece of the tourmaline thus rendered practically white, when fused into a borax-bead coloured blue by copper oxide, immediately gave rise to red spots and streaks of $Cu^2 O$, thus showing that the iron had not been converted into $Fe^2 O^3$, but that deoxidation had really been effected, as proved by the change of colour. [1]

(3) Experiment No. 2, with slight modifications, was repeated on other black crystals. All were decolourised, some assuming a pale-greyish or yellowish-white colour, and others a delicate pink tint.

(4) A small, dark-green, translucent crystal of Brazilian tourmaline was treated as in experiment No. 2, but the heat was kept up somewhat longer. The crystal remained unfused, although slightly rounded on the edges; but it was rendered opaque and dull greyish-white in colour. In these green and other translucent examples of tourmaline, it is probable that the iron is only partially in the condition of $Fe^3 O^4$; and that in lightly-tinted examples it may be wholly present as Fe O. But in schorl or black tourmaline, I hold that it is essentially if not wholly in the state of ferro-ferric oxide, and that consequently the earlier view of the constitution of tourmaline is in this respect correct.

NOTE.—Want of leisure has prevented me from extending these investigations to other black or deeply-coloured silicates, with the exception of some melanites or black garnets from Frascati. Ignited in an open crucible, these became fused or rounded, but retained their dark colour. Treated, as in experiment No. 2, in a reducing mixture in a covered crucible, they became, practically, white or greyish-white, but presented at the same time a singular phenomenon. Perfectly solid crystals (of sp. gr. averaging 3.80) separated into two portions, an outer and an inner portion. The outer part expanded to about three times the original bulk of the crystal, forming a thin sheath, within which lay the whitened but only partially-fused central portion, like a nut within its shell. This bears out an observation made some years ago by Rosenbusch, that many garnets differ externally and internally, as regards colour and composition—his remark applying especially to these black garnets. Damour, in his analysis of a black garnet from Frascati, obtained a small amount of titanic acid, and he attributed the black colour to the presence of titanic oxide, seeing that many light-coloured garnets contain more iron. But in these lightly coloured subspecies, the iron may be regarded as present in the condition of ferrous oxide, whilst in melanite (or, at least, in the black external portion of that mineral) it is probably entirely in the form of the ferro-ferric compound, $Fe^3 O^4$.

None of these crystals gave by fusion with sodium carbonate and nitre more than the very feeblest reaction of manganese.

IV.—*Time-Reckoning for the Twentieth Century.*[1]

By SANDFORD FLEMING, C.M.G., LL.D., C.E., etc.

(Presented May 26, 1886.)

During the early historical ages much chronological confusion prevailed, and it is largely owing to this cause that the annals of the centuries which preceded the Christian era are involved in obscurity. The attempt to end this general disorder was made by Julius Cæsar who established regulations with respect to the divisions of time and the mode of reckoning to be followed. The Julian Calendar was introduced forty-six years before Christ. It continued unchanged until the sixteenth century. In 1582 recognition was obtained of the errors and defects which the circumstances of the period had made manifest and which demanded correction. Pope Gregory XIII accordingly directed the Reformation of the Calendar and established new rules of intercalation. These two epochs are certainly the most important in the history of our chronology.

Three centuries have passed since the reform of Pope Gregory. New continents have been opened to civilization and immense regions then wholly unknown to Europe have been peopled by races busied in commerce and skilled in the arts, and characterized by unwearied energy and determination. In these three hundred years a marvellous succession of inventions bearing upon human activity and progress has been introduced, and the character of nearly every requirement of life has undergone change. The discoveries and inventions which have marked this period have produced new conditions of society; and our minds have received an impulse, which leads to investigation wherever need of improvement appears to be demanded. It is within the last half century more especially that the bounds of human knowledge have been so wonderfully extended; perhaps in the whole world's annals no fifty years have witnessed such a marvellous revolution. The triumphs of applied science in facilitating intercourse between men and nations have given an extraordinary impulse to general progress, but in so doing they have developed imperfections in our system of time-notation which previously were unknown, and it is no longer possible to escape the conviction that we have reached a stage when further reform is demanded as a requirement of our condition. The necessity for a reform in time-reckoning is recognized by the highest authority and has obtained a hold of public opinion. The President of the United States, General Arthur, at the

[1] In submitting this paper to the Royal Society of Canada, it is proper to explain that it was prepared by request for the Smithsonian Institution, with a view to publication in the Smithsonian Reports. The object is to bring out prominently the true principles by which the several nationalities may be guided in the notation of time. It is communicated to the Royal Society, with the full knowledge and concurrence of the authorities of the Smithsonian Institution, who desire to coöperate in the movement of time-reform by diffusing knowledge on this important question in all countries where their publications circulate.

request of Congress authoritatively took proceedings to bring the subject prominently to the attention of the world. After prolonged diplomatic correspondence with the Governments of foreign powers, he invited delegates from all nations to a scientific conference at Washington in which the subject should be fully considered.

The Conference met in the autumn of 1884. Twenty-five nationalities were represented. The proceedings extended over the month of October, and they resulted in the almost unanimous adoption of seven resolutions bearing upon time-reckoning.

As no records can be in accord unless a common starting point be agreed upon from which computations are to be made, the first resolutions had reference to the determination of an initial meridian. The meridian passing through Greenwich was selected.

In the fourth and fifth resolutions the Conference laid down the following important principles:—

IV. "That the Conference proposes the adoption of a Universal Day for all purposes for which it may be found convenient and which shall not interfere with the use of local or other standard time where desirable."

V. "That the Universal Day is to be a mean solar day: is to begin for all the world at the moment of mean midnight of the initial meridian, coinciding with the civil day and date of that meridian, and is to be counted from zero to twenty-four hours."

The opening of the National Congress at Washington shortly followed the International Conference. The President regarded the importance of the proceedings to be such as to call for special mention of them in his annual message. General Arthur thus expressed himself on the subject: "The Conference concluded its labours on the first of November, having with substantial unanimity agreed upon the meridian of Greenwich as the starting point whence Longitude is to be computed through one hundred and eighty degrees eastward and westward, and upon the adoption, for all purposes for which it may be found convenient, of a Universal Day, which shall begin at midnight on the initial meridian and whose hours shall be counted from zero up to twenty-four."

There was no exaggerated importance in these allusions, for the conclusions of the Conference are productive of most important results. They make provision for terminating all ambiguity in hours and dates and for establishing throughout the world, free from national susceptibility and caprice, perfect uniformity in reckoning time. Some years may elapse before the new notation becomes the one recognized mode of reckoning; but when it shall have been generally accepted in the practice of daily life, it is calculated to sweep away the difficulties now experienced and it will add greatly to the general convenience of civilized man.

One of the first practical efforts to direct public attention to the rapidly growing necessity for a comprehensive reform in time-reckoning can be found in a paper published in the Transactions of the Canadian Institute, Toronto, for the session of 1878-79.[1] This paper adduces in support of its argument many pertinent facts, and points out that the gigantic systems of railways and telegraphs which in modern times have been established in both continents have developed social and commercial conditions which never previously existed. These conditions have so affected the relations of time and distance as to establish the fact that our inherited system of notation is defective; that it is inconvenient to

[1] Time-Reckoning and the selection of a Prime Meridian to be common to all Nations. By Sandford Fleming.

men of business; that it produces confusion and frequently results in loss of life, and leads to other difficulties; that under the circumstances which have followed the substitution of steam for animals as a motive power, the ancient usages as retained in our notation of hours and dates are generally inappropriate. Moreover, the use of the telegraph in our daily lives, practically subjects the whole surface of the globe to the observation of civilized communities in each individual locality. It leaves no interval of time between widely separated places proportionate to their distances apart. It practically brings into close contact the opposite sides of the earth where daylight and darkness prevail at the same period. By this agency, noon, midnight, sunrise, sunset, and the whole range of intermediate gradations of the day, are all observed and recognized at the same moment. Thus in matters out of the domain of local importance, confusion is developed and all count of time is thrown into multiplied disorder.

Again, under the usages now observed, a day is assumed to begin twelve hours before, and end twelve hours after, the sun passes the meridian of any place. As the globe is constantly revolving on its axis, a fresh meridian is every moment coming under the sun; as a consequence a day is always beginning somewhere and always ending somewhere. Each meridian around the circumference of the sphere has its own day, and therefore it results that there are, during every diurnal revolution of the earth, an infinite number of local days all beginning within a space of twenty-four hours and each continuing twenty-four hours. These days overlap each other, but they are as perfectly distinct as they are infinite in number. While a day is nominally 24 hours in length, as a matter of fact 48 hours elapse between the first beginning and the last ending of every week day. Taking the whole globe into our view, Sunday actually commences in the middle of Saturday and lasts until the middle of Monday. Again Saturdays runs into the middle of Sunday, while Monday begins 24 hours before Sunday comes to an end and continues 24 hours after Tuesday commences. Similarly for all the days of the week, as time is now reckoned. Except those on the same meridian, there are no simultaneous days on the earth's surface, and as the different days are always in the various stages of advancement, discrepancies and errors must necessarily result in assigning the precise period when an event takes place. The telegraph may give the exact local time of an occurrence, but the time so given must be in disagreement with local time on every other meridian around the globe. An event occurring on any one day may on the instant be announced in a locality where the time is that of the previous day, and in another locality where the time is that of the following day. About the period when the month or year passes into another month or year, an occurrence may actually take place, according to our present system of reckoning, in two different months or in two different years; indeed, there can be no certainty whatever with regard to time, unless the precise geographical position be specified as an essential fact in connection with the event described. Under these circumstances it must be conceded that our present system of notation is most defective; certainly it is unscientific, and possesses every element of confusion: it produces a degree of ambiguity which, as railways and telegraphs become greatly multiplied, will lead to complications in social and commercial affairs, to errors in chronology, to litigation in connection with succession to property, insurance, contracts, and other matters; and in view of individual and general relationships it will undoubtedly act as a clog to the business of life and prove an increasing hindrance to human intercourse.

The problem to be mastered is to put an end to this confusion. In order to do so, it is important that we should endeavour to form correct ideas of time and its attributes.

According to the ordinary usages which we follow, the time of any particular locality depends upon its position on the earth's surface, in other words, upon its longitude. The principle followed is that there is a separate time on every meridian around the circumference of the globe. Let us carry this theory to its logical conclusion. Take by way of example a hundred or a thousand meridians, each with a distinct and separate time. It will be conceded that what is true of one point on a meridian must be true of every point. A meridian line runs due north and south on the earth's surface, from pole to pole; hence it follows that, at the point where every meridian must converge, we have the time of every meridian. That is to say, at the earth's pole, a point common to every meridian, there are a hundred or a thousand different notations of time, each distinct and separate. The extreme absurdity of this hypothesis establishes beyond question that the premises are false; and it is in no way surprising that confusion and difficulty result from a system such as we possess, based on principles so erroneous.

We may here ask the question: "Why should time vary with every mile of longitude?" The answer comes:—It is not possible to conceive more than a single unity of time in the whole universe. Time which is "an infinite continuity in infinite space" resembles a mighty river whose unvarying stream passes before us. Such a river is unchangeable yet continually changing: volumes of water always advancing are replaced by new volumes in perpetual succession, and yet the river continues one and the same ever flowing unity. The passing stream of time is much the same, and the problem presented to us is to keep a proper record of its flow. It is perfectly obvious that the principles which should govern should be such as to secure complete accord in the detail of its admeasurement independently of locality. All peoples are concerned in the attainment of harmonious results, and therefore it is important that they should acquiesce in the employment of the same unit of computation and in counting the measurements from one common zero.

We have not to look in vain for a convenient unit and the most perfect instrument for measuring the passage of time. The rotation of the earth on its axis is marked by complete uniformity of movement, and nothing is more certain than the recurrence of this diurnal phenomenon. Accordingly the earth itself supplies all our wants as a timekeeper: in it we have at our command a perpetual standard for the use and guidance of the entire family of man.

Before, however, we can attain this end it is essential that mankind should come to an agreement on the following points:—

1. With respect to a zero from which the revolutions are to be counted.

2. The acceptance of a common subdivision and a common notation by which parts of revolutions will be known by all and receive universal recognition.

The importance of a definite understanding on these points is self-evident, for if each individual or group of individuals adheres to the practice of observing time from different zeros and each maintains separate reckonings of it, the outcome must be general confusion such as we now experience.

If in imagination we place ourselves at one extremity of the earth's axis, we shall find ourselves in a peculiarly favourable position, free from all local influences, for observing

the revolutions of the globe. At no other point in the northern hemisphere are the conditions the same. A spectator standing at the north pole would have neither east nor west; in whatever direction he might cast his eyes he would look towards the south; he would no longer see the daily return of sunrise and sunset; the sun when visible would move, or seem to move, in a horizontal line, and its path would encircle the earth parallel to and not far distant from the horizon. Under such circumstances it would not be possible to note the diurnal revolutions of the earth by the rising or setting of the sun, or by the sun's greatest altitude at mid-day, or by his southern position in the heavens. As the passage of time can only be marked by events, what course could be followed? Obviously it would be necessary to take special means to observe the earth's diurnal rotation, and the method most readily to suggest itself would be to select a conspicuous object near the horizon and according to this object observe the sun's passage over it. The object so selected would become the zero of time, and the interval between two successive solar passages would be the period occupied by a revolution of the earth. If from zero the horizon be divided into a series of arcs of 15° each, the whole circle around will consist of twenty-four divisions. If each of the division points be numbered from zero in the direction contrary to the motion of the earth or towards the right, and in imagination the numbers be placed in a conspicuous manner against the sky, the spectator will have within his range of vision a great dial-plate on which as it revolves the vertical sun will continually point to the passing hours. With the twenty-four division points so numbered around the circle of the horizon, it is obvious that every hour in the day, and equally the smaller divisions of time, will invariably be manifested by the solar passage.

As the imaginary point of observation, the north pole, is common to every meridian, the hours and minutes indicated by the great polar chronometer will be equally common to every locality on the surface of the globe. Whatever the longitude, the solar passage will be the index of time. Two successive passages at zero will complete an interval of twenty-four hours, but it will not be a day in the ordinary sense, as an ordinary day is a local phenomenon in no two longitudes identical.[1] To distinguish this new interval of time common to the whole world from the infinite number of local days at present recognized, it has been suggested to term it the "Cosmic Day," or some distinctive appellation by which it may be known.

Necessarily the zero point must be arbitrarily selected according to convenience, and any zero whatever, other things being equal, would serve the purpose which we have in view. We have only to assume the zero so selected to coincide with the Antiprime Meridian determined by the Washington Conference, and the Cosmic Day will be identical with the Universal Day established under the same authority. A Universal or Cosmic Day may therefore be defined as the interval of time between two succeeding Solar passages at the Antiprime Meridian common to all nations.

In his recent discourse on the subject at the Royal Institution, London, the Astronomer Royal for Great Britain, Mr. Christie, expressed a preference for the term "World Time" to designate this new measure of duration. It has been termed "Cosmic Time" by various societies and individuals; but the name is of secondary importance if it be understood that

[1] The Nautical Almanic defines an ordinary Solar day to be the interval of time between the departure of *any meridian* from the Sun and its succeeding return to it.

the new measure of time is equally related to every locality. By its very nature, "Cosmic Time," or by whatever name it may be known, must coincide with some one of the multiplicity of existing times. The decision of the Washington Conference caused it to correspond with Greenwich Civil Time. Greenwich time is the local time of Greenwich. Cosmic Time is a new and an entirely different conception, it is the time of the world common to every nation. "Cosmic" and "Greenwich" time are identical fortuitously, but the expressions imply two totally different ideas, and a proper deference to national sensitiveness suggests the good taste and expediency of distinguishing the two ideas by different terms. Some distinctive name is undoubtely called for, until the period arrives when the unification of time will be complete. In the not far distant future it may become equally as unnecessary to speak of "Solar," "Lunar," "Astronomical," "Civil," "Nautical," "Local," Cosmic," or "World" Time, as at present it is unnecessary to attach these or other distinctive appelations to "Space." The simple expression "Time" may then become sufficient for all purposes.

1 LONGITUDE East and West from Greenwich.	2 LONGITUDE West from Time Zero.	3 LONGITUDE By Hour Meridians.	4 COSMIC TIME. At Mean Solar Passage.
180° Antiprime Meridian..	Zero of Cosmic Time and of Longitude.		Change of the Day.
165° East	15°	Hour Meridian No. 1	1 o'clock.
150° East	30°	" 2	2 "
135° East	45°	" 3	3 "
120° East	60°	" 4	4 "
105° East	75°	" 5	5 "
90° East	95°	" 6	6 "
75° East	105°	" 7	7 "
60° East	120°	" 8	8 "
45° East	135°	" 9	9 "
30° East	160°	" 10	10 "
15° East	165°	" 11	11 "
0° The Prime Meridian..	180°	" 12	12 "
15° West	195°	" 13	13 "
30° West	210°	" 14	14 "
45° West	225°	" 15	15 "
60° West	240°	" 16	16 "
75° West	255°	" 17	17 "
90° West	270°	" 18	18 "
105° West	285°	" 19	19 "
120° West	300°	" 20	20 "
135° West	315°	" 21	21 "
150° West	330°	" 22	22 "
165° West	345°	" 23	23 "
180° Antiprime Meridian..	360° and 0°	Zero and No. 24	24 " and change.

The relation between time and longitude is important. If longitude be reckoned by hour meridians as in the second and third columns of the table, that is to say numbered continually westward from the Antiprime Meridian, which is the true time zero, the in-

habitants of every individual locality in whatever longitude will daily have an opportunity of regulating time by the great natural standard of measurement. The longitude of the locality being known, at mean solar passage the time will, invariably and precisely, agree with the longitude. Conversely, the time being known, the longitude of the place will be in strict agreement with time at the moment of mean solar passage.

A reference to the plate will make it clear that the solar passage will be the invariable index of Cosmic Time. Fig. 1 shows the relative position of sun and earth at the initial instant of the Cosmic Day, that is, at the moment of mean solar passage on the Antiprime Meridian adopted by the Washington Conference.

Fig. 2. Gives the position when the earth has made a sixth of a revolution and four hours have elapsed. The solar passage at this stage is on the four-hour meridian.

Fig. 3. When the earth has made a third of a revolution and occupied a period of eight hours, the solar passage occurs on the eight-hour meridian.

Fig. 4. When the earth has made half a revolution and twelve hours have elapsed, the solar passage is at this stage on twelve-hour or Prime Meridian.

Similarly for every other meridian, and thus the precise relation between Cosmic Time and longitude is definitely established.

It may be said that Cosmic or Universal Time is accepted in science, but its adoption in ordinary life can only be gradually and perhaps with difficulty effected. It is not to be looked for that a change so marked, involving a revolution of thought in some of our social customs, can be speedily introduced, however desirable it may be in the public interest. There is a class of men who habitually express their contempt for what they designate as "new-fangled notions" and who refuse to go out of sight of old landmarks. The usages which we desire to supersede are certainly old, for they took their origin when our civilization was young. In those days it was a dogma that the earth had a flat surface, but as the belief that the earth is a plane is no longer invested with the authority of a truth, we may venture to call in question the theory that each locality on its surface possesses an independent stream of time and is called upon to defend and maintain it. The human race is no longer confined within a narrow area. It has overspread the surface of the earth; in the old and new worlds it has grown, in some portions of their extent it is still growing, from an infantile condition to a state of manhood. Are we not yet able to look beyond one individual horizon, and enlarge our range of vision so as to include a system which will satisfy the requirements, not of a locality, but of the whole globe?

We are living in an age of intellectual and social progress, when men are less fettered than our fathers were by the restraints of custom. On the continent of North America extraordinary progress has already been made by an essentially practical people towards the adoption of a complete reform in time-reckoning. What is known as the Standard Hour system, in itself in complete harmony with the principles of Cosmic Time, has been in common use for nearly three years, and it is generally recognized as an incalculable benefit to the whole community.

Throughout the United States and Canada, we have outgrown the notion of isolating each locality by compelling it to observe a separate time notation. The Continent is divided into zones, each zone having the same time throughout its extent, based on a meridian which is a multiple of fifteen degrees from the Prime Meridian. Consequently

the time of each zone varies exactly one hour from that of the adjoining zones. Thus all the variations of time which formerly were limited only by the number of towns and cities and localities w ich observed their own local time, are reduced to the five zones. Only at points where the zones come in contact is there any exception to the common satisfaction which has resulted from the change. These are the only localities where we find the old time difficulties, now so happily removed from every other section of the Continent. At such localities the difficulties must continue to be felt until Cosmic Time comes into general use, for it is the one remedy which can satisfy every requirement.

The Standard Hour system is an effective preliminary means for the introduction of universal time, and it is not confined to North America. In Sweden as well as Great Britain the principle is in common use. The Standard time of Sweden is based on the meridian fifteen degrees east of the prime meridian, consequently an hour in advance of the Prime Meridian time. The time of Great Britain is that of the prime meridian itself.

The scheme of hour meridians can only be regarded as a provisional arrangement. It greatly lessens the difficulties experienced, but it does not wholly remove them. It is, however, an important practical step towards the general unification of time as it brings the minutes and seconds into complete agreement with the world's time wherever the system is adopted. The Astronomer Royal of Great Britain calls particular attention to the breadth of view evidenced by the managers of the American railways who were so largely instrumental in having this important step taken. "By adopting a national meridian as the basis of their time-system, they might have rendered impracticable the idea of a universal time to be used by Europe as well as America. But they rose above national jealousies and decided to have their time-reckoning based on the meridian which was likely to suit the convenience of the greatest number; thus doing their utmost to promote uniformity of time throughout the world by setting an example of the sacrifice of human susceptibilities to general expediency."

There is one feature of time-refor m alluded to by President Arthur in his message to Congress which promises before long to be accepted by the community. I refer to the proposal to count the hours from zero to twenty-four. The recent report of the special committee on Standard Time of the American Society of Civil Engineers (January, 1886) thus alludes to this branch of the subject:—

"This feature has the authority of the International Conference for its introduction. In intelligent circles in Europe, particularly in England and in Russia, also at the antipodes in Australia, the proposal is reported to have been greeted with enthusiasm. The Astronomer Royal of England, Mr. Christie, has established at Greenwich Observatory a division of the great dial into 24 hours. In London and in other cities, public clocks have been also changed to accustom the English public to this division of the day. Some newspapers in all their annoucements adopt the change, and scientific societies give notice of their meetings in the same manner as this Society, according to the 24-hour system.

"On this Continent there has been no uncertain sound. In the last annual report of the Committee it was stated that 171 managers of railways in the United States and Canada had declared their readiness to abandon the division of the day into half-days, known as *ante* and *post* meridian, and to accept the numeration of the hours in one series, from midnight to midnight,—these managers having under their control some 60,000 miles of railway.

"During the past year the seed sown has been fructifying and many who held back have been won over and have given their adhesion to the movement. Among the many important railways ready to coöperate, some appear to see no necessity for further delay, and desire to secure at once the advantages which will result from the change. At this date it is publicly announced that the Canadian Pacific Railway Company have determined to adopt the 24-hour system, and are actually preparing to make the change at an early day.[1] Such proceedings can be accepted as indicating a proper appreciation of the reform which the American Society of Civil Engineers has advocated, and equally shows the discernment of those who direct the management of the youngest of the transcontinental railways. This practical commencement will, without a doubt, be speedily followed by other railway companies, and before long we may look for the 24-hour system coming into general use." [2]

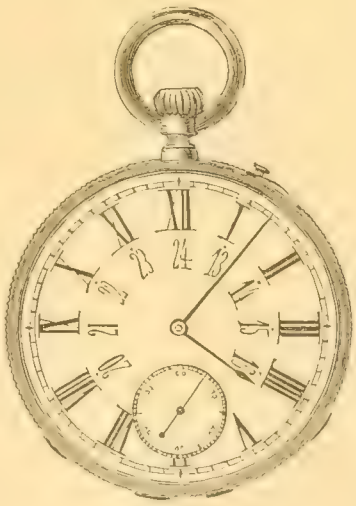
There is undoubtedly a growing feeling in many quarters in favour of the twenty-four hour system. It is reported to be used with great advantage on the whole of the cables and other lines of the Eastern Telegraph Company, and its connections extending from England through Europe and the Mediterranean to Egypt, and from Egypt to South Africa, India, China and Japan, Australia and New Zealand.

It is a pertinent question to ask, what influence these various changes will have in preparing the public mind for another, and it may be said a final change, the adoption of one uniform time in every longitude? For it must be evident to the thoughtful observer that the movement for reforming our time-system will not have attained its object until this end be accomplished.

Those persons who have been in the habit of finishing their daily work at 6 p.m. under the twenty-four hour system will end it at 18. Those who retired to rest at 10 or 11 p.m. will seek their beds at 22 or 23. The idea that solar noon and 12 o'clock are one

[1] At midsummer 1886, the Canadian Pacific Railway was opened from the Atlantic to the Pacific and the twenty-four hour system went into force in running "through" trains. The example set by the railway company has been followed in the Towns and Villages along the line, and the inhabitants generally having experienced the advantages of the change, no desire is expressed in any quarter to return to the old usage.

[2] The following foot note is added:—"It is proposed to adapt clocks and watches now in use to the change, by having inscribed on the existing dials the new numbers of the afternoon hours,—thirteen to twenty-four (13 to 24) inclusive, as in the Plate. The only practical difficulty to be overcome is met by the simple expedient of placing on the face of the watch or clock a supplementary dial showing the new afternoon hours in Arabic numerals within the present Roman figures. The supplementary dial, must be of thin material, and it has been found that by being made simply of paper and secured to its position by any gum which will adhere to an enamelled surface, the object is attained without any further alteration of the watch or clock. The Committee is aware that these seem trifling matters to bring under the notice of the Convention, but questions of great moment not seldom hinge on small details. It is evident from what has been set forth, that every person in the community, may at the cost of a few cents in each case, adapt his watch to the 24 hour system. The Committee accordingly repeat their conviction that with the disappearance of the only practical difficulty at an insignificant cost, there is nothing to prevent the Railway authorities and the Community at large adopting the change as soon as they become alive to its advantages."—Report at the Buffalo Convention of the American Society of Civil Engineers.



and inseparable has already been set aside throughout the United States and Canada; only on five meridians, the 60th, 75th, 90th, 105th and 120th, is it held to be 12 o'clock at the mean solar passage. In all other longitudes throughout North America the identity between solar noon and 12 o'clock has practically been swept away.

These modifications in time-reckoning must tend to remove the idea that there is some necessary connection between the numbers of the hours and the position of the sun in each local firmament. The force of habit has heretofore associated noon with 12 o'clock, but in due time it will become obvious to every one that the hour of the sun's passage at any one locality may with as much propriety be distinguished by any one of the twenty-four numbers as by the now generally received number 12. So soon as this new idea comes generally to be accepted, so soon as it is understood that the numbers of the hours are arbitrary and conventional, it will not be difficult to take the final step in time-reform and entirely supersede the present system by a notation which will give to mankind throughout the world simultaneous dates and hours and minutes.

The final step may appear to involve serious changes in much which concerns every individual, but it is not to be supposed that it will in any way interfere with the periods for labour, sleep, meals, or any ordinary usage. The one change will be in the numbers of the hours. In social affairs the regulating influence of daylight and darkness will always, as now, be paramount. The terms "noon" and "midnight" will continue to preserve their present meaning, although the numbers of the hours at which these periods occur will vary in each case according to longitude. Each separate meridian will have its own midnight hour distinguished from the midnight hours of other meridians by a distinctive number. So also with the noon hour, which as already stated will invariably agree with the longitude of the place. It is the midnight hour in each locality which will constitute the initial time-point to regulate the legal hours for opening and closing banks, registry and other public offices. The midnight hour may be arbitrarily chosen and be established by statute as circumstances may demand. It will be held to be the local zero to govern the hours of business, working hours, the hours for attendance at church, at school, and at places of amusement, and generally to regulate all the social affairs of life. While the seven week days will practically remain unchanged in every longitude, the simple expedient of numbering the hours so that everywhere they will correspond with Cosmic Time will result in securing the general uniformity to be desired. Thus it will be obvious that in all matters relating to time, whether local or non-local, the same hours, minutes and seconds will universally be observed at the same instant. In cases when business men separated by long distances make contracts by telegraph, the engagements will be free from all ambiguity as to time. Both parties will be bound absolutely by the same notation.

The Cosmic Day is a new measure of time, entirely non-local. It will be held to be the date of the world, and the change of date will occur at the same instant in all longitudes. On the prime meridian the change of date will be at midnight; to the east it will occur after midnight; and to the west of the prime meridian it will come before midnight. It will be one hour before or after midnight for every fifteen degrees of west or east longitude. Fortunately, in nearly all the important countries on the surface of the globe, the change of date will occur out of ordinary business hours.

It will thus be seen that while the contemplated reform will interfere as little as pos-

sible with existing customs, it will result in giving to the human family around the globe concurrent dates, and in making every division of time uniform the world over.

In the adoption of the new system, temporary inconvenience may arise, but it will be trifling in extent and not of long duration; and any momentary disadvantage should not be allowed to weigh against the benefits to be secured to mankind for all future ages.

On the night of November 18th, 1883, a noiseless revolution was effected throughout the United States and Canada. The hands of the clocks of some fifty millions of people were for the most part moved forward or backward in order to indicate the time of one of the five hour zones. The time now observed from the Atlantic coast to the Pacific varies with Cosmic Time according to situation from four to eight whole hours. In North America therefore, the portion of the problem yet to be adjusted is easy of solution. As the minutes and seconds are already everywhere in agreement, the transition to universal uniformity of reckoning can be effected simply and with ease. It will only be necessary to move forward the dial hands of the clocks an even number of hours, varying from four to eight as each case may require, to bring the Continent into complete accord with the time of the world.

When eventually it may become necessary to bring the time throughout all parts of North America to the world's standard, the transition may be effected by adjusting the clocks as follows:—

I.—Clocks in the Hour Zones of the West Meridians.

Meridian West.		Hours.
60°	..... will have to be moved *forward*	4
75°		5
90°		6
105°		7
120°		8

Similarly wherever the scheme of hour meridians be adopted, the common reckoning may with equal ease be secured. To the west of the prime meridian, the clocks will require to be moved forward, to the east backward. In Europe, Asia and Africa the change would thus be effected:—

II.—Clocks in the Hour Zones of the East Meridians.

Meridian East.		Hours.
15°	..... will have to be moved *backward*	1
30°		2
45°		3
60°		4
75°		5
90°		6

Thus for example, New Orleans in the hour zone of the 90th meridian west would have its clocks advanced six hours, while Calcutta in the 90th meridian east would have its clocks retarded six hours. By the same simple process of transition, every city and district on the surface of the globe may be brought to the one common time-reckoning.

It is a significant fact that at the Washington Conference the principle of Universal Time obtained unanimous recognition from the delegates of so many nationalities. It is a presage that the peoples whom they represent will before long be fully impressed with the belief that a system of reckoning time uniformly throughout the globe is really the one rational system by which it can be noted, and the only system which will meet the demands of the human family in coming years. It is only step by step that a reform so great can be carried out. Moreover, although the difficulties to be overcome are undoubtedly serious, this much may be said with confidence, that they are less formidable than those which have already been conquered. A few years back the very question of a universal time for all nations was a theory not only new in itself but it was held by many to be wild and Utopian, and so impracticable as to be unworthy of consideration. In 1878 the subject could not command a hearing at the British Association! Since 1878 the arguments advanced to point out the necessity of change have, however, obtained attention, and a general movement for reform has been inaugarated. Scientific and practical men and learned societies in both hemispheres have taken part in the consideration of the question. It has formed the subject of discussion at International Congresses at Venice and Rome. The President and Congress of the United States have been induced to take decisive action in connection with it. The Governments of twenty-five civilized nations have aided in its development. The International Washington Conference itself has greatly promoted the solution of the problem by coming to an unanimous determination on the essential principles to be observed. In several countries the recommendations of the Conference have already in part been acted on, and changes have been effected which a few years back were not even dreamed of.

If so much has been accomplished within the eight years since the scheme of reform was first promulgated, is it too much to expect that the public mind will be prepared in the more advanced communities to accept the final step in a like period?

In fourteen or fifteen years we pass into another century. Is it taking too sanguine a view to suggest that by that time all nations will be willing to accept the change, and that the first day of January in the Twentieth Century may appropriately be inaugurated by the adoption of one uniform system of reckoning time throughout the world?

I learn from the recent lecture of the Astronomer Royal that the Board of Visitors of Greenwich Observatory have unanimously recommended that in accordance with the resolutions of the Washington Conference, the Astronomical day should in the English Nautical Almanac be arranged from the year 1891 (the earliest practicable date) to begin at Greenwich midnight so as to agree with the civil reckoning, and further that steps have been taken to give effect to this recommendation; thus in a few years this source of confusion to sailors navigating ships using the Nautical Almanac—embracing at least seventy per cent. of the tonnage of the world—will be removed. The distinguished Russian Astronomer, Struve, has suggested that all astronomers throughout the world should simultaneously abandon Astronomical Time and bring their notation into harmony with the civil reckoning. He further suggests that this reform should be introduced into the publications of observatories at the initial day of the century.[1] The same epoch

[1] In reference to this the Astronomer Royal, Greenwich, says (Oct., 1885) "it would be intolerable to have a fundamental question of time-reckoning left open for fifteen years."

seems equally appropriate for a general change and the complete unification of time-reckoning. Every auxiliary circumstance points to the possibility of that result being attained. The proceedings of the Washington Conference have given the movement an immense impulse. Its members have authoritatively recognized the principles on which the new notation may be established. So unimpeachable and simple are these principles as to be within the grasp of the most limited comprehension. In their application we may have to contend against the prejudices engendered by habit and custom, but the principles of reckoning time adopted by the Conference are based on truth and they commend themselves to every one of intelligence, as the proper means to meet the admitted emergency. The unanimity with which the Standard Hour system was brought into common use in North America is an evidence that the age is sufficiently intelligent to adopt a reform when its advantages are understood. It will doubtless require the lapse of some years to win over those who feel it to be a bounden duty to cling to old institutions and existing customs. Gradually, however, the minds of the great mass of men will become familiarized with the new ideas and in the end the new system of notation cannot fail to prevail. The main obstacles to be overcome are the restraints which tradition imposes and the usages which our ancestors have transmitted to us. But prejudices of this character can be gradually and certainly surmounted, if the true principles of time-reckoning be taught in schools and colleges. In a few years the youth of to-day will be moving actors in life, to influence public opinion and so effect an easy escape from the thraldom of custom. We have therefore good grounds for the belief that, by the dawn of the coming century, the civilized nations may enjoy a system of notation limited to no locality; when the record of the events of history will be unmarked by doubt; when ambiguity in hours and dates will be at an end; when every division of time will be concurrent in all longitudes.

These expectations realized, the Washington Conference will have rendered a great service to mankind. If the reforms of B. C. 46 and A. D. 1582 owed their origin to the dominant necessity of removing confusion in connection with the notations which existed in the then conditions of the human race, in no less degree is a another reform demanded by the new conditions which are presented in this age. The needed change could not be effected at a more suitable period than at the beginning of the new century, but whether then consummated or at some other date, full provision is made for it in the conclusions and recommendations of the Washington Conference, which in all probability will be held by future generations to mark an epoch in the annals of the world not less important than those of the reforms of Julius Cæsar and Pope Gregory XIII.

V. — *Du choix d'une projection pour la carte du Canada.*

Par E. DEVILLE.

(Lu le 27 mai 1886.)

Quand un géographe construit une carte, il ne suffit pas qu'il y représente avec une exactitude minutieuse la topographie du pays, il faut encore que la projection qui sert de base à son travail soit bien choisie.

Le nombre des projections connues est trop considérable pour que nous les passions toutes en revue : nous examinerons seulement les principales, ou celles qui présentent des avantages spéciaux pour le Canada.

On peut quelquefois réduire de moitié les erreurs absolues d'une projection en modifiant convenablement l'échelle. Si, par exemple, dans la projection stéréographique, on adopte une échelle telle que les distances près du centre soient diminuées dans le même rapport que celles des bords sont agrandies, l'erreur absolue ne sera plus que la moitié de ce qu'elle était quand l'échelle était exacte au centre. Pour la facilité des comparaisons, nous considèrerons l'altération totale, c'est-à-dire la somme des deux altérations, positive et négative.

Les limites adoptées dans ce mémoire pour la carte du Canada sont le détroit d'Hudson, l'extrémité est de Terre-Neuve, l'extrémité sud du lac Michigan, le mont Saint-Elie et l'intersection du rivage de la mer polaire par la frontière de l'Alaska. Cette carte comprend 50 degrés de grand cercle dans un sens et 25 degrés dans l'autre.

PROJECTIONS ZÉNITHALES

Les propriétés caractéristiques des projections zénithales sont que les cercles verticaux passant par le zénith sont représentés par des droites faisant entre elles des angles égaux à ceux de la sphère et les almicantarats par des cercles ayant pour centre commun le point d'intersection des méridiens ; elles sont par conséquent symétriques par rapport au zénith.

Nous ne nous occuperons pas des cas particuliers dans lesquels le plan de l'équateur ou celui d'un méridien sont pris comme plans de projection : les erreurs y sont évidemment plus considérables qu'en employant le plan de l'horizon. Ils rentrent d'ailleurs dans le cas général, en supposant le zénith placé au pôle ou sur l'équateur.

PROJECTION STÉRÉOGRAPHIQUE. — L'œil est placé à l'extrémité d'un diamètre et la surface de la sphère est projetée en perspective sur un plan perpendiculaire à ce diamètre. Cette projection est orthomorphe, c'est-à-dire qu'elle conserve la similitude des surfaces élémentaires. Les distances augmentent comme le carré de la sécante de la moitié de la

distance zénithale, et les surfaces comme le carré de cette quantité. Pour le Canada l'altération des distances est de 0·071, et celle des surfaces de 0·145. En modifiant l'échelle ainsi qu'il a été expliqué, on réduit ces qualités à 0·035 et 0·071.

Projection gnomonique. — Le point de vue est au centre de la sphère, dont on projette la surface en perspective sur le plan de l'horizon. Les arcs de grand cercle sont représentés par des lignes droites, propriété qui rendrait ce système précieux pour mettre en évidence les avantages des voies canadiennes pour les communications entre l'Europe et l'Asie orientale. Les déformations sont considérables : sur les parallèles, les distances sont augmentées dans le rapport de l'unité au cosinus de la distance zénithale ; sur les méridiens le rapport est le carré du précédent. Pour la carte du Canada, ces altérations sont de 0·15 et 0·32. En modifiant l'échelle on peut réduire l'altération maximum à 0·16.

Projection zénithale équivalente de Lambert. — Les verticaux d'azimut sont représentés par des lignes droites se croisant au centre de la carte et les parallèles par des cercles concentriques dont le rayon est égal à la corde de la distance zénithale. Les surfaces sont conservées, mais les distances sont raccourcies dans le sens des verticaux et augmentées sur les almicantarats. L'augmentation est dans le rapport de l'unité au cosinus de la moitié de la distance zénithale : la diminution est l'inverse. Pour la carte du Canada, l'altération est 0·035, positive et négative, soit une altération totale de 0·070.

Projection zénithale équidistante. — Les verticaux sont représentés comme précédemment et les almicantarats sont des cercles concentriques dont le rayon est égal à la distance zénithale. Les distances sur les verticaux sont donc conservées, mais dans le sens des almicantarats, elles augmentent dans le rapport de la distance zénithale à son sinus. Les surfaces augmentent dans la même proportion. Cette altération est de 0·047 pour la carte du Canada. Cette projection a été employée sous la forme polaire, par les ministères de l'intérieur et de l'agriculture pour représenter en même temps le Canada et l'Europe. Dans ce cas, l'altération attteint 0·13.

Projection orthographique. — La surface de la sphère est projetée au moyen de perpendiculaires sur le plan de l'horizon. Sur les almicantarats, les distances sont conservées ; elles diminuent sur les verticaux, ainsi que les surfaces, dans le rapport du sinus à l'arc de la distance zénithale. Cette diminution est de 0·047 pour la carte du Canada.

Projection de sir Henry James. — Le point de vue est placé sur le diamètre passant par le zénith, à une distance du centre égale à une fois et demi le rayon de la sphère. En désignant par θ la distance zénithale, l'agrandissement des distances est dans le sens des verticaux :

$$\frac{2.5 + 3.75 \cos \theta}{(1.5 + \cos \theta)^2}$$

Et dans le sens des almicantarats :

$$\frac{2.5}{1.5 + \cos \theta}$$

Pour la carte du Canada, ces altérations sont de 0·027 et 0·057. Les surfaces sont augmentées de 0·085.

Projection par balance d'erreurs de sir G. Airy. — C'est une projection zénithale dans le genre des précédentes : le rayon des almicantarats est égal à :

$$tang\,\frac{\theta}{2} + 2\,cotang\,\frac{\theta}{2}\,\mathrm{L}\,sec\,\frac{\theta}{2}$$

Pour la carte du Canada, les distances sont augmentées de 0·011 sur les verticaux et de 0·054 sur les almicantarats. Les surfaces sont augmentées de 0·065.

Projections coniques

On développe un ou plusieurs cônes tangents à la sphère sur lesquels on a projeté la surface du globe. Ce système est le plus général ; les projections zénithales n'en sont qu'un cas particulier dans lequel l'angle au sommet du cône est de 180°. Les projections cylindriques s'y ramènent aussi en faisant ce même angle égal à zéro. Nous ne considérerons ici que les projections coniques polaires, c'est-à-dire dans lesquelles le sommet du cône est situé sur la ligne des pôles ; ce sont les seules usitées. Les parallèles y sont représentés par des arcs de cercle et les méridiens généralement par des lignes droites se coupant au pôle.

Projection conique orthomorphe de Lambert. — Le rayon des parallèles est donné par la formule :

$$\rho = k\left(tang\,\frac{z}{2}\right)^{\lambda}$$

dans laquelle ρ est le rayon, z la distance polaire, k et λ des constantes qui déterminent, l'une l'échelle de la carte, et l'autre le rapport des angles des méridiens sur la carte et sur le globe. Les distances sont augmentées dans le rapport :

$$\frac{\lambda\,\rho}{sin\,z}$$

L'agrandissement des surfaces est le carré de cette quantité.

En prenant λ égal au sinus de la latitude moyenne, ce qui est la valeur la plus favorable, on trouve que ces agrandissements sont, pour la carte du Canada, respectivement égaux à 0·046 et 0·094.

Projection conique équivalente de Lambert — Le rayon des parallèles est exprimé par la formule

$$\rho = 2\sqrt{m}\,sin\,\frac{z}{2}$$

m est une constante arbitraire qui exprime le rapport de l'angle au pôle des méridiens sur la carte et sur la sphère, $2\,sin\frac{z}{2}$ est la corde de la distance polaire.

Les distances sont diminuées sur les méridiens et augmentées dans la même proportion sur les parallèles. La diminution sur les méridiens est dans le rapport de

$$\sqrt{m} \cos \frac{z}{2}$$

à l'unité.

En prenant pour m le carré de la sécante de la moitié de la distance polaire moyenne, on trouve que l'altération positive ou négative est pour la carte du Canada, égale à 0·043, soit une altération totale de 0·086.

Projection conique équidistante. — Le rayon du parallèle moyen est égal à la tangente de la distance polaire et les degrés de ce parallèle ainsi que ceux des méridiens, conservent leur véritable grandeur. Tous les autres parallèles sont agrandis dans le rapport :

$$\frac{(\alpha + \tan z) \cos z}{\sin (\alpha + z)}$$

z désignant la distance polaire du parallèle moyen et α la distance de ce même parallèle à celui que l'on considère. Les surfaces sont agrandies dans la même proportion. L'altération est de 0·09 pour le Canada.

Cette projection a été employée pour la carte des écoles de la province de Québec.

Projection de Bonne. — C'est une projection conique équidistante dans laquelle les degrés des parallèles sont portés en vraie grandeur sur les cercles qui les représentent. Les méridiens sont des courbes qui passent par les points ainsi déterminés. Les surfaces sont conservées, mais les distances ne le sont que sur les parallèles. La quantité ϕ, dont l'angle d'un méridien et d'un parallèle diffère de 90°, est donnée par la formule :

$$\tan \phi = t \cos z - \frac{t \sin z}{\tan z_0 - \tan (z_0 - z)}$$

dans laquelle t est la différence de longitude avec le méridien moyen, z_0 et z les distances polaires du parallèle moyen et de celui que l'on considère. Pour la carte du Canada, cet angle est de près de 10°.

Cette projection a été employée pour la carte du Canada publiée par Johnston de Edimbourg, d'après laquelle de nombreuses cartes ont été tracées.

Projection polyconique ordinaire. — Pour expliquer cette projection, sir Henry James suppose qu'on découpe la surface de la sphère suivant les parallèles, et qu'on développe la surface en conservant les points de contact sur le méridien moyen.

Le méridien moyen est une ligne droite sur laquelle les degrés sont portés en vraie grandeur. Les rayons des parallèles sont égaux à la cotangente de la latitude. Les degrés de ces parallèles sont portés en vraie grandeur sur les cercles qui les représentent et on trace les méridiens en joignant les points ainsi déterminés.

Pour la carte du Canada, l'agrandissement des méridiens près des bords est de 0·12 ; celui des surfaces est à peu près le même. Cette projection est très employée ici : la carte publiée par le département des chemins de fer et canaux a été tracée d'après ce système.

Projections cylindriques

Projection cylindrique orthomorphe ou de Mercator. — L'équateur est développé en ligne droite et les méridiens sont des perpendiculaires à cette ligne. Les cercles de latitude sont des parallèles à l'équateur, à la distance ;

$$S = L \, tang \left(45^\circ + \frac{l}{2}\right)$$

où l désigne la latitude. Cette distance est connue sous le nom de latitude croissante.

L'agrandissement des surfaces est dans le rapport :

$$\frac{1}{cos\, l}$$

Et celui des surfaces :

$$\frac{1}{cos^2\, l}$$

Pour la carte du Canada, en se servant de l'échelle du bord inférieur, on trouve les distances plus que doublées au bord supérieur ; les surfaces sont quintuplées.

Ce système est celui des cartes marines ; il aussi été employé pour la carte des télégraphes publiée par le ministère des Travaux Publics.

Projection cylindrique équivalante de Lambert. — Un cylindre droit étant circonscrit à l'équateur, les méridiens et les parallèles sont représentés par l'intersection de leurs plans avec la surface du cylindre.

Les distances sur les parallèles sont augmentées dans le rapport de l'unité au cosinus de la latitude, et sur les méridiens elles sont diminuées d'autant. Pour la carte du Canada, cette déformation atteint 2·07.

Projection sur le cylindre sécant. — On construit un cylindre perpendiculaire à l'équateur sur le parallèle moyen de la carte. Les degrés de latitude sont portés en vraie grandeur sur les génératrices.

Les distances en longitude sont augmentées d'un côté du parallèle moyen et diminuées de l'autre, dans le rapport de :

$$\frac{cos\, l_0}{cos\, l}$$

l_0 et l étant les latitudes du parallèle moyen et de celui que l'on considère. Ceci donne pour la carte du Canada un agrandissement de 0·63 d'un côté et une diminution de 0·24 de l'autre, soit une altération totale de 0·87.

Cette projection a été employée pour la carte des territoires du Nord-Ouest et de la Colombie anglaise, publiée par Dawson frères, de Montréal.

Projection sur un cylindre oblique. — On détermine le grand cercle de la sphère qui divise le pays à représenter suivant sa plus grande longueur en deux parties à peu près égales, et sur ce grand cercle, on circonscrit un cylindre droit. On y projette les méridiens et parallèles auxiliaires suivant l'un quelconque des systèmes cylindriques équatoriaux, et l'on calcule leurs intersections avec les méridiens et parallèles véritables, puis on joint les points d'intersection.

Il serait possible de tenir compte exactement de l'aplatissement de la terre, en calculant les rayons de courbure de l'équateur et des méridiens auxiliaires et portant sur chacun d'eux les degrés en vraie grandeur, mais cela entraînerait des calculs compliqués, et il est suffisant dans le cas qui nous occupe de prendre pour rayon de la terre la moyenne des rayons de courbure de l'équateur auxiliaire et du méridien central.

En désignant par l, la latitude de l'intersection d'un méridien véritable avec l'équateur auxiliaire, α l'angle de ces deux lignes, θ la différence en longitude du méridien central à celui considéré, μ la distance de leurs points d'intersection avec l'équateur auxiliaire, et λ la latitude de l'intersection de cet équateur par le méridien central, ou à :

$$\cos \alpha = \sin \theta \sin \lambda$$
$$\tan \mu = \tan \theta \cos \lambda$$
$$\tan l_1 = \tan \lambda \cos \theta$$

Les coordonnées x et y de chaque point d'intersection d'un cercle de latitude l avec un méridien sont données par les formules :

$$\tan x = \tan (l - l_1) \cos \alpha$$
$$\sin y = \sin (l - l_1) \sin \alpha$$

On peut construire les méridiens et parallèles auxiliaires en projection de Mercator ; dans ce cas on aura une projection orthomorphe. Si l'on désire conserver les surfaces, on emploiera la projection équivalente de Lambert.

Une petite carte du Canada, dressée sur ce système, est actuellement en cours d'exécution au ministère de l'intérieur ; les méridiens et parallèles auxiliaires ont été projetés sur le cylindre sécant. Sur l'équateur auxiliaire les distances sont diminuées de 0·012 et augmentées d'autant aux bords supérieurs et inférieurs de la carte, soit une altération totale de 0·024. Les surfaces sont altérées dans la même proportion.

Ce système a l'inconvénient d'exiger des calculs assez longs et qu'il faut recommencer toutes les fois qu'on change les limites de la carte. Si au lieu de représenter tout le Canada, on ne voulait en montrer qu'une partie, il faudrait, rigoureusement parlant, calculer une nouvelle projection, mais la déformation est si faible qu'on pourra se dispenser de le faire et la projection générale, quoique n'étant pas la meilleure pour les cartes particulières, sera cependant amplement suffisante pour tous les besoins pratiques.

Conclusion

De ce qui précède on peut conclure que la projection la plus exacte pour le Canada, de toutes celles qui ont été examinées, est la projection cylindrique oblique. On a vu que l'altération peut y être réduite à 0·012, erreur du même ordre de grandeur que celle qui est causée par le retrait du papier après l'impression, et par conséquent négligeable dans bien des cas. Pour ceux que la longueur des calculs effraie, on peut recommander la projection conique orthomorphe de Lambert. La construction en est simple, et l'altération totale de 0·046 peut être réduite à 0·023 en modifiant l'échelle. La propriété dont jouit cette projection de conserver la similitude des surfaces est un avantage important, principalement lorsqu'on se propose de publier la carte en feuilles séparées.

La projection polyconique ne convient pas pour les latitudes élevées, et ne devrait jamais être employée pour les cartes du Canada.

VI.—*Supplement to "A Natural System in Mineralogy, etc."*

By T. STERRY HUNT, M.A., LL.D.

(Presented May 27, 1886.)

§ 1. In the Transactions of this Society for 1885 appears a paper by the present writer entitled "A Natural System in Mineralogy, with a Classification of Native Silicates." (Vol. III. Sec. iii. pp. 25-93.) In printing that paper, a considerable number of errors crept into the tables of the various tribes of silicates in the values of P and V, and sometimes of D also, together with other errors in the formulas themselves. These tables, having been revised with care, are here reproduced, with the use of initial letters for the crystalline systems, and other changes, which permit them to be printed in a more compact form. In thus reprinting them, with the entire paper and some additions, in the author's "Mineral Physiology and Physiography" (a volume now in the press), certain comments which originally appeared in the right-hand columns of these tables have been incorporated with the text.

§ 2. In further extension of the principles of classification which we have adopted for the silicates, it should be said that bismuthic oxyd is to be reckoned with aluminic, chromic, ferric, manganic and zirconic oxyds; so that the bismuthic silicates, eulytite, agricolite and bismutoferrite belong to the sub-order of the Persilicates, and moreover, by their chemical characters, and their volumes, represent in that sub-order the spathoid type, of which no examples were known to the writer at the time of preparing the previous paper. They thus find a place in the tribe of the Perspathoids, as shown below in the revised synoptical table of the sub-order. Therein also the stannic silicate described by Breithaupt, in 1847, by the name of stannite may, perhaps, find a place among Peradamantoids. Its specific gravity of 3.55, much below that of a corresponding mixture of cassiterite and quartz, leads to the conclusion that it is really a chemical compound. The name of stannite was subsequently, in 1868, applied by Dana to tin pyrites, the stannine of Beudant, but as its application by Breithaupt has priority, the sulphuretted tin pyrites may be called stannipyrite.

Zirconic silicates are represented in the third sub-order of silicates by the adamantoid species, zircon, lyncurite, auerbachite, and malacone, and in the second sub-order by catapleiite among zeolitoids, and by eudialyte, wöhlerite and astrophyllite among spathoids and phylloids. It is, moreover, a question whether oërstedite may not be a zirconic adamantoid of this sub-order.

§ 3. To recall the atomic notation here used to represent the quantivalent ratios in silicates, we subjoin the tabular view giving the symbols employed and their numerical values, hydrogen being unity (h = 1.00):—

Atomic Symbols and Weights.							
aq	9.00	cs	133.00	cu	31.65	fi	18.66
o	8.00	gl	4.50	ni	29.00	mni	18.50
s	16.00	mg	12.00	zn	32.50	bi	69.33
fl	19.00	ca	20.00	ce	47.00	si	7.00
cl	35.50	sr	43.75	yt	44.50	ti	12.50
li	7.00	ba	68.50	b	3.66	zr	22.50
na	23.00	fe	28.00	al	9.00	th	58.00
k	39.00	mn	27.50	cri	17.33	nb	18.80

The proposed classification of the mineral kingdom, and the place therein of the silicates, is given in the next table, in which are seen the four classes of Metalline, Oxydized, Haloid and Combustible bodies, with their orders and sub-orders, as follows :—

Classes.	Orders and Sub-Orders.
I.	1. Metallates: *a.* Metallometallates; *b.* Spathometallates.
II.	2. Oxydates.—3. Silicates: *a.* Protosilicates; *b.* Protopersilicates; *c.* Persilicates.—4. Titanates.—5. Niobates.—6. Tantalates.—7. Tungstates.—8. Molybdates.—9. Chromates.—10. Vanadates.—11. Antimonates.—12. Arsenates.—13. Phosphates.—14. Nitrates.—15. Sulphates.—16. Borates.—17. Carbonates.—18. Oxalates.
III.	19. Haloidates: *a.* Fluorids; *b.* Chlorids; *c.* Bromids; *d.* Iodids.
IV.	20. Pyricaustates: *a.* Carbates; *b.* Carbhydrates.

In the subjoined list of the tribes of the three sub-orders of the order Silicate and their respective species, some additions and a few changes have been made in the latter.

Sub-Order I. Protosilicate.....	Tribe 1.	Hydroprotospathoid (Pectolitoid).
	Tribe 2.	Protospathoid.
	Tribe 3.	Protadamantoid.
	Tribe 4.	Protophylloid.
	Tribe 5.	Protocolloid (Ophitoid).
Sub-Order II. Protopersilicate....	Tribe 6.	Hydroprotoperspathoid (Zeolitoid).
	Tribe 7.	Protoperspathoid.
	Tribe 8.	Protoperadamantoid.
	Tribe 9.	Protoperphylloid.
	Tribe 10.	Protopercolloid (Pinitoid).
Sub-Order III. Persilicate.....	Tribe 11.	Hydroperspathoid (Perzeolitoid).
	Tribe 12.	Perspathoid.
	Tribe 13.	Peradamantoid.
	Tribe 14.	Perphylloid.
	Tribe 15.	Percolloid (Argilloid).

TRIBE 1. PECTOLITOID. Calamine, Thorite, Cerite, Gyrolite, Friedelite, Pyrosmalite, Xonaltite, Plombierite, Dioptase, Pectolite, Datolite, Apophyllite, Okenite; together with Villarsite, Matricite, Picrosmine, Picrolite, and Chrysotile. (Table I.)

TRIBE 2. PROTOSPATHOID. Danalite, Willemite, Batrachite, Tephroite, Knebelite, Gadolinite, Helvite, Leucophanite, Wollastonite, Tscheffkinite. (Table II.)

TRIBE 3. PROTADAMANTOID. Chondrodite, Monticellite, Chrysolite, Phenacite, Bertrandite, Amphibole, Rhodonite, Pyroxene, Enstatite, Guarinite, Titanite, Danburite. (Table III.)

TRIBE 4. PROTOPHYLLOID. Thermophyllite, Marmolite, Talc. (Table IV.)

TRIBE 5. OPHITOID. Serpentine, Retinalite, Deweylite, Genthite, Aphrodite, Cerolite, Chrysocolla, Spadaite, Rensselaerite, Sepiolite, Glauconite. (Table V.)

TRIBE 6. ZEOLITOID. Xanthorthite, Hamelite, Catapleiite, the various Zeolites; with Cancrinite and Ittnerite, Edingtonite, Sloanite, Forestite. (Table VI.)

TRIBE 7. PROTOPERSPATHOID. Melilite, Eudialyte, Wöhlerite, Humboldtilite, Ilvaite, Gehlenite, Sarcolite, Milarite, Barylite, Meionite, with Marialite and intermediate Scapolites, Sodalite, Nosite, Hauyne, Lapis-lazuli, Leucite, Hyalophane, Orthoclase, Microcline, Nephelite, Paranthite, Eucryptite, Anorthite, Albite and intermediate Feldspars, Iolite, Petalite. (Table VII.)

TRIBE 8. PROTOPERADAMANTOID. Pargasite, Keilhauite, Idocrase, Glaucophane, Schorlomite, Garnet, Ægirite, Allanite, Beryl, Euclase, Prehnite, Arfvedsonite, Ardennite, Axinite, Epidote, Zoisite, Jadeite, Gastaldite, Acmite, Spodumene, Sapphirine, Staurolite; and the Tourmalines, including Coronite, Schorlite, Aphrizite, Indicolite, Rubellite. (Table VIII.)

TRIBE 9. PROTOPERPHYLLOID. Astrophyllite, Phlogopite, Pyrosclerite, Penninite, Ripidolite, Prochlorite, Cronstedite, Leuchtenbergite, Venerite, Corundophilite, Biotite, Voigtite, Cryophyllite, Seybertite, Thuringite, Jefferisite, Annite, Willcoxite, Chloritoid, Lepidomelane, Zinnwaldite, Oellacherite, Lepidolite, Margarite, Euphyllite, Cookeite, Damourite, Paragonite, Muscovite. (Table IX.)

TRIBE 10. PINITOID. Jollyte, Fahlunite, Esmarkite, Bravaisite, Sordavalite, Hygrophilite, Pinite, Cossaite; with Palagonite, Tachylite, Pitchstone, and Obsidian. (Table X.)

TRIBE 11. PERZEOLITOID. No species known except perhaps Westanite.

TRIBE 12. PERSPATHOID. No species known to represent this tribe except the bismuthic silicates Eulytite, Agricolite, and Bismutoferrite.

TRIBE 13. PERADAMANTOID. Dumortierite, Topaz, Andalusite, Fibrolite, Cyanite, Bucholzite, Xenolite, Wörthite, Lyncurite, Malacone, Zircon, Auerbachite, Anthosiderite, (Table XI.)

TRIBE 14. PERPHYLLOID. Pholerite, Talcosite, Kaolinite, Pyrophyllite. (Table XII.)

TRIBE 15. ARGILLOID. Schrötterite, Collyrite, Allophane, Samoite, Halloysite, Kaolin, Keramite, Hisingerite, Wolchonskoite, Montmorillonite, Chloropal, Cimolite, Smectite. (Table XIII.)

§ 4. The subjoined tribal tables include the principal species of each tribe (except Tribes 11 and 12, which are not tabulated), their atomic formulas, so far as determined, and the values of P and V, as calculated from these—P being the unit-weight or mean weight of the oxyd-unit in the species, and V, the volume of this, got by dividing P by D = the specific gravity. For the crystalline tribes, the form of the species, when known, is designated in these tables in the right hand column, under X; initial letters being used as follows:—I, Isometric; T, Tetragonal; O, Orthorhombic; C, Clinorhombic; A, Anorthic or Triclinic; H, Hexagonal, and R, Rhombohedral.

§ 5. Prehnite was by Breithaupt included in his order *Grammites*, and in the order of *Zeolites* by Shephard, following whom, it was, by the author, placed among Zeolitoids. It is, however, shown by its volume, hardness, and chemical relations, to be an adamantoid, and has accordingly been transferred, in the revised tables, to the eighth tribe. To this are now also added glaucophane and gastaldite, two aluminous protopersilicates, whose nearest relations are with garnet, epidote and jadeite. The latter species, with P = 16·88 and D = 3·32, gives V = 5·08; while gastaldite, having the same general formula, with P = 17·08 and D = 3·04, gives V = 5·61; and dipyre, almost identical in formula, with

P = 16·89 and D = 2·64, has V = 6·39. We have thus presented three stages of condensation in similar silicates.

§ 6. In the species of the colloid type—represented among the various sub-orders of

TABLE I.—PECTOLITOIDS.

SPECIES.	FORMULA.	P	D	V	X
Calamine	$(zn_1si_1)o_2 + \frac{1}{2}aq$	24.00	3.50	6.87	O.
Thorite	$(th_1si_1)o_2 + \frac{2}{3}aq$	32.62	5.30	6.15	I.
Cerite	$(ce_1si_1)o_2 + \frac{1}{2}aq$	29.80	4.90	6.08	?
Gyrolite	$(ca_2si_3)o_5 + 1aq$	18.33	....	....	?
Friedelite . . .	$(mn_2si_3)o_5 + 2aq$	19.14	3.07	6.23	R.
Pyrosmalite . .	$(fe_2si_3)o_5 + 1aq$	21.58	3.17	6.80	H.
Chrysotile . . .	$(mg_3si_4)o_7 + 2aq$	15.33	2.22	6.98	?
Xonaltite . . .	$(ca_1si_2)o_3 + \frac{1}{4}aq$	18.53	2.71	6.83	?
Plombierite . .	$(ca_1si_2)o_3 + 2aq$	15.20	....	....	?
Dioptase	$(cu_1si_2)o_3 + 1aq$	19.67	3.31	5.88	R.
Pectolite	$(ca_5si_{12})o_{17} + 1aq$	18.27	2.78	6.57	C.
Datolite	$(ca_2si_4b_3)o_9 + 1aq$	16.00	2.99	5.35	C.
Apophyllite . . .	$(ca_1si_4)o_5 + 2aq$	15.14	2.35	6.44	T.
Okenite	$(ca_1si_4)o_5 + 2aq$	15.14	2.35	6.44	O.

silicates, by the Ophitoids, Pinitoids and Argilloids, and corresponding to the order *Porodini* and the various porodic species of Breithaupt—are included, not only pure colloids like chrysocolla and allophane, but admixtures of colloids with crystalloids, as in the case

TABLE II.—PROTOSPATHOIDS.[1]

SPECIES.	FORMULA.	P	D	V	X
Danalite. - - -	$(m_7si_6)o_{13}$ - (m = gl, fe, zn) - *a*	22.15	3.43	6.76	I.
Willemite. - -	$(zn_1si_1)o_2$ - - - - - - - - -	27.75	4.18	6.63	H.
Batrachite. - -	$(m_1si_1)o_2$ - (m = $ca_{0\cdot5}mg_{0\cdot5}$) - -	19.50	3.03	6.43	O.
Tephroite. - - -	$(mn_1si_1)o_2$ - - - - - - - -	25.25	4.12	6.13	O.
Knebelite. - - -	$(m_1si_1)o_2$ - (m = $fe_{0\cdot5}mn_{0\cdot5}$) - -	25.37	4.12	6.15	?
Gadolinite. - -	$(m_1si_1)o_2$ - (m = gl, yt, fe) - *b*	25.66	4.20	6.10	O.
Helvite. - - -	$(m_1si_1)o_2$ - (m = gl, mn) - - -	20.16	3.30	6.11	I.
Leucophanite. -	$(m_3si_4)o_7$ - (m = gl, ca, na) - *c*	18.05	2.97	6.07	O.
Wollastonite. - -	$(ca_1si_2)o_3$ - - - - - - - - -	19.33	2.92	6.62	C.
Tscheffkinite. -	$(m_1si_2)o_3$ - (m = ce, ca, fe) - *d*	27.00	4.26	6.34	?

of partially devitrified obsidian and pitchstone, and of chalcedony, a colloidal aggregate of quartz and opal, the latter a typical colloid. Such admixtures, however, having the

[1] The formulas employed in calculating the values of P and V for the following species are

a. Danalite — $(gl_{3\cdot0}fe_{2\cdot0}mn_{0\cdot5}zn_{1\cdot5}si_{6\cdot0})o_{12\cdot0}s_{1\cdot0}$.

b. Gadolinite — $(gl_{2\cdot00}yt_{2\cdot00}fe_{0\cdot75}ce_{0\cdot25}si_{4\cdot00})o_{9\cdot00}$.

c. Leucophanite — $(ca_{5\cdot0}gl_{5\cdot0}na_{2\cdot0}si_{16\cdot0})o_{28\cdot0}$.

d. Tscheffkinite — [Damour] $ce(_{0\cdot65}fe_{0\cdot20}ca_{0\cdot15}si_{1\cdot30}ti_{0\cdot70})o_{3\cdot00}$.

external characters of colloidal or porodic substances, are placed in the colloid tribes; to which, in the synoptical tables, we have added sordavalite and hisingerite, the latter being regarded as a simple ferric silicate, and thus in the third sub-order.

For the colloids included under the tenth tribe, the very variable composition of the vitreous products of igneous fusion has been insisted upon in § 103, 104 of the previous paper. As regards the limits of species in these and similar cases, the question which

TABLE III. — PROTADAMANTOIDS.

SPECIES.	FORMULA.	P	D	V	X.
Chondrodite. - -	$(mg_4si_3)o_7$ - - - - - - - -	18.64	3.20	5.82	O.
Monticellite. - -	$(m_1si_1)o_2$ - $(m = mg_{0\cdot5}ca_{0\cdot5})$ - -	19.50	3.25	6.00	O.
Forsterite. - -	$(mg_1si_1)o_2$ - - - - - - - - -	17.50	3.30	5.30	O.
Chrysolite (1). -	$(m_1si_1)o_2$ - $(m = mg_{0\cdot9}fe_{0\cdot1}$ - -	18.30	3.40	5.38	O.
Chrysolite (2). -	$(m_1si_1)o_2$ - $(m = mg_{0\cdot8}fe_{0\cdot2}$ - -	19.10	3.50	5.45	O.
Bertrandite. - -	$(gl_1si_1)o_2 + \frac{1}{4}aq$ - - - - - - -	13.22	2.59	5.10	O.
Phenacite. - -	$(gl_1si_1)o_2$ - - - - - - - - -	15.75	3.00	4.58	R.
Amphibole (1). -	$(m_1si_2)o_3$ - $(m = mg_{0\cdot75}, ca_{0\cdot25})$ -	17.33	2.97	5.88	C.
Amphibole (2). -	$(m_1si_2)o_3$ - $(m = mg_{0\cdot6}ca_{0\cdot3}fe_{0\cdot1})$ -	18.00	3.06	5.88	C.
Rhodonite. - -	$(mn_1si_2)o_3$ - - - - - - - -	21.83	3.60	6.06	C.
Pyroxene (1). -	$(m_1si_2)o_3$ - $(m = ca_{0\cdot3}mg_{0\cdot5})$ - -	18.00	3.27	5.50	C.
Pyroxene (2). -	$(m_1si_2)o_3$ - $(m = ca_{0\cdot3}mg_{0\cdot5})$ - -	18.00	3.28	5.48	C.
Pyroxene (3). -	$(m_1si_2)o_3$ - $(m = ca\frac{1}{3}mg\frac{2}{3})$ - -	17.55	3.22	5.45	C.
Pyroxene (4). -	$(m_1si_2)o_3$ - $(m = ca\frac{4}{5}mg\frac{3}{8}fe\frac{1}{8})$ -	18.66	3.41	5.47	C.
Enstatite (1). -	$(m_1si_2)o_3$ - $(m = mg_{0\cdot9}fe_{0\cdot1})$ - -	17.20	3.10	5.54	O.
Enstatite (2). -	$(m_1si_2)o_3$ - $(m = mg_{0\cdot8}fe_{0\cdot2})$ - -	17.73	3.25	5.45	O.
Titanite. - - -	$(ca_1si_2ti_2)o_5$ - - - - - - - -	19.80	3.50	5.65	C.
Guarinite. - - -	$(ca_1si_2ti_2)o_5$ - - - - - - - -	19.80	3.50	5.65	T.
Danburite. - -	$(ca_1si_4b_3)o_8$ - - - - - - - -	15.37	3.00	5.12	O.

arises is similar to that presented by the various intermediate feldspars and scapolites, (which we have elsewhere discussed), and by the intermediate carbon-spars, and is one intimately connected with the high molecular weights which must be assigned to mineral species.

TABLE IV. — PROTOPHYLLOIDS.

SPECIES.	FORMULA.	P	D	V	X.
Thermophyllite.	$(mg_3si_4)o_7 + 2aq$ -	15·33	2·61	5·87	?
Marmolite. - -	$(mg_3si_4)o_7 + 2aq$ -	15·33	2·41	6·35	?
Talc. - - - -	$(mg_4si_{10})o_{14} + 1aq$ -	15·93	2·70	5·90	O.
Talc. - - - -	$(mg_3si_9)o_{12} + \frac{3}{4}aq$ -	15·82	2·60	6·07	O.

§ 7. In the chemical relations of the protoxyds on the one hand, and of alumina on the other, upon which, in our system, the sub-orders of silicates are based, a fundamental difference appears in the fact that when silicated compounds of the former undergo subaerial decay—that is to say, are decomposed by the action of carbonated atmospheric

waters—the protoxyd bases are liberated from combination with the silica, which itself is, in great part, like the protoxyds, dissolved. In the case of the aluminous double silicates thus decomposed (chiefly feldspars and scapolites) while the protoxyd bases, with more or less silica, are in like manner dissolved, the alumina remains behind as a definite hydrous silicate. The zirconia of the few zirconic protopersilicates known, would, it is conjectured, behave like alumina; and the existence in nature of such compounds as wolchonskoite and chloropal shows in chromic and ferric oxyds (which are not dissolved by carbonated waters) a similar affinity for silica. The changes in oxydation of iron and manganese from atmospheric oxygen, on the one hand, and from certain organic matters on the other, modify, in ways which are well known, the relations of these metals in decaying silicates. The titanium which may be present in silicates thus decomposing probably separates as titanic dioxyd, since in the younger crystalline schists it generally appears in this state, crystallized as rutile.

§ 8. In the essay on a Natural System in Mineralogy to which this is a supplement, attention was called (§§ 29, 31, 65) to the unlike effects of agents which, like chlorhydric and nitric acids, combine with their bases, upon silicates of similar centesimal composition. As examples of this were cited the cases of meionite as compared with zoisite, and of wollastonite with amphibole and pyroxene. Illustrations, moreover, are not wanting in the similarly related species of other orders, as in the behavior of the different carbon-spars, such as calcite, dolomite and magnesite, with the same acids, or of tridymite and quartz with

TABLE V. — OPHITOIDS.

SPECIES.	FORMULA.	P	D	V
Serpentine. - -	$(mg_3si_4)o_7 + 2aq$	15·33	2·65	5·78
Retinalite. - -	$(mg_3si_4)o_7 + 2\frac{1}{2}aq$	15·00	2·40	6·25
Deweylite. - -	$(mg_2si_3)o_5 + 3aq$	14·00	2·25	6·22
Genthite. - - -	$(ni_2si_3)o_5 + 3aq$	18·25	2·40	7·60
Aphrodite. - -	$(mg_1si_2)o_3 + \frac{3}{4}aq$	15·13	2·21	6·84
Cerolite. - - -	$(mg_1si_2)o_3 + 1\frac{1}{2}aq$	14·11	2·30	6·13
Chrysocolla. - -	$(cu_1si_2)o_3 + 2aq$	17·53	2·24	7·82
Spadaite. - - -	$mg_5si_{12})o_{17} + 4aq$	15.04	—?	....
Rensselaerite. -	$(mg_4si_{10})o_{14} + 1aq$	15·93	2·70	5·90
Sepiolite. - - -	$(mg_1si_3)o_4 + 1aq$	14·80	—?	....
Glauconite. - -	- - - - - -	....	....	....

a solution of sodium carbonate. The conclusion was then announced (§ 35) that for species so related "*the hardness and chemical indifference are inversely as the value of V*, or in other words, they increase with the condensation, the relative amount of which in the species compared is shown by the diminution of V;" which is the quotient got by dividing the combining weight of the chemical unit, or unit-weight, P by the density or specific gravity D (water = 1.000). We were thus led to insist upon the fundamental importance of specific gravity in solid species, considered not in itself, but in relation to the mean unit-weight. This, which was assumed for Silicates and for Oxydates—as that of the compound of eight

parts of oxygen (or its equivalent) with hydrogen, silicon, boron, aluminium, sodium or other metal—is readily calculated from the empirical formula of the species.

§ 9. Attention has, moreover, been called, in an essay entitled "The Genetic History of Crystalline Rocks," presented to the Royal Society of Canada at the present meeting (May, 1886) to the indifference of certain silicates to fluorhydric acid, which, as is well known, attacks many such compounds, and combines not only with the contained bases but with the silica itself. It was therein noticed that, as shown by different observers, zircon, staurolite, amphibole, pyroxene and chrysolite, resist more or less completely the action of this solvent, so that, as Fouqué and others have found, these silicates may be separated from feldspars, and from vitreous colloid or porodic silicates like obsidian—all of which are readily dissolved by fluorhydric acid.

TABLE VI.—ZEOLITOIDS.

SPECIES.	FORMULA.	P	D	V	X
Xanthorthite.-	$(m_1al_1si_2)o_4+2aq$ - (m=ce, fe) - - -	....	2.90	...	C.
Hamelite. - -	$(m_1al_2si_3)o_6+1aq$ - (m = mg, fe, na)	....	...	...	?
Catapleiite. -	$(m_1zr_2si_6)o_9+2aq$ - - - - - - - -	18.09	2.80	6.46	H.
Cancrinite. -	$(na_6al_{18}si_{27})o_{51}+3c_1ca_1o_3+4\frac{1}{2}aq$ - -	....	2.42	...	H.
Thomsonite. -	$(m_1al_3si_4)o_8+2\frac{1}{2}aq$ - $(m=ca_{\frac{1}{4}}na_{\frac{3}{4}})$ -	13.58	2.38	6.54	O.
Gismondite. -	$(ca_1al_3si_{4\cdot50})o_{8\cdot50}+4\frac{1}{2}aq$ - - - - - -	14.38	2.26	6.36	O.
Natrolite. - -	$(na_1al_3si_6)o_{10}+2aq$ - - - - - - -	15.83	2.25	7.03	O.
Scolecite. - -	$(ca_1al_3si_6)o_{10}+3aq$ - - - - - - - -	15.08	2.40	6.28	C.
Mesolite. - -	$(m_1al_3si_6)o_{10}+3aq$ - $(m=ca_{\frac{2}{3}}na_{\frac{1}{3}})$ -	15.15	2.40	6.31	C.
Levynite. - -	$(ca_1al_3si_6)o_{10}+4aq$ - - - - - - -	14.64	2.16	6.77	R.
Pollucite. - -	$(m_1al_3si_8)o_{12}+1aq$ - $(m=cs_{\frac{2}{3}}na_{\frac{1}{3}})$ -	21.46	2.90	7.40	I.
Analcite. - -	$(na_1al_3si_8)o_{12}+2aq$ - - - - - - - -	15.71	2.29	6.86	I.
Eudnophite. -	$(na_1al_3si_8)o_{12}+2aq$ - - - - - - -	15.71	2.27	6.92	O.
Laumontite. -	$(ca_1al_3si_8)o_{12}+4aq$ - - - - - - -	14.68	2.30	6.38	C.
Herschelite. -	$(m_1al_3si_8)o_{12}+5aq$ - $(m=na_{\frac{3}{4}}k_{\frac{1}{4}})$ - -	14.76	2.06	7.16	O.
Phillipsite. -	$(m_1al_3si_8)o_{12}+5aq$ - $(m=ca_{\frac{2}{3}}na_{\frac{1}{3}})$ -	14.41	2.20	6.55	O.
Chabazite. -	$(ca_1al_3si_8)o_{12}+6aq$ - - - - - - - -	14.05	2.19	6.41	R.
Gmelinite. -	$(m_1al_3si_8)o_{12}+6aq$ - $(m=ca_{\frac{1}{2}}na_{\frac{1}{2}})$ -	14.11	2.17	6.50	R.
Faujasite. - -	$(m_1al_3si_9)o_{13}+9aq$ - $(m=na_{\frac{1}{2}}ca_{\frac{1}{2}})$ -	13.45	1.92	7.00	I.
Hypostilbite -	$(ca_1al_3si_9)o_{13}+6aq$ - - - - - - - -	14.10	2.20	6.40	?
Harmotome. -	$(m_1al_3si_{10})o_{14}+5aq$ - $(m=ba_{\frac{9}{10}}na_{\frac{1}{10}})$	16.73	2.45	6.82	O.
Epistilbite. -	$(ca_1al_3si_{12})o_{16}+5aq$ - - - - - - -	14.47	2.25	6.43	O.
Brewsterite. -	$(m_1al_3si_{12})o_{16}+5aq$ - $(m=sr_{\frac{2}{3}}na_{\frac{1}{3}})$ -	15.27	2.45	6.23	C.
Stilbite. - -	$(ca_1al_3si_{12})o_{16}+6aq$ - - - - - - -	14.23	2.20	6.46	O.
Heulandite. -	$(ca_1al_3si_{12})o_{16}+5aq$ - - - - - - -	14.47	2.20	6.58	C.
Edingtonite. -	$(ba_1al_4si_7)o_{12}+4aq$ - - - - - - -	17.84	2.71	6.58	T.
Sloanite. - -	$(ca_1al_5si_7)o_{13}+3aq$ - - - - - - -	15.31	2.44	6.27	O.
Forestite. - -	$(ca_1al_6si_{12})o_{19}+6aq$ - - - - - - -	14.56	2.40	6.06	O.

Meanwhile, Mr. J. B. Mackintosh, of the School of Mines, Columbia College, New York, having tried this acid to distinguish between certain gems, called my attention in April, 1886, to the fact that garnet was unattacked by it, an indifference ascribed by me to the great condensation of this silicate, which is near that of the adamantoids already men-

tioned. I then suggested, in order to test the correctness of this view, comparisons between the adamantoids, epidote and spodumene, on the one hand, and the spathoids, iolite and petalite, on the other; predicting that these latter would, like the feldspars, be attacked, and the former would resist the action of fluorhydric acid. The correctness of this prevision was confirmed by the results of Mr. Mackintosh's experiments, communicated to me April

TABLE VII. — PROTOPERSPATHOIDS.

SPECIES.	FORMULA.	P	D	V	X
Melilite. - -	$(ca_2m_1si_3)o_6$ - $(m = al\frac{1}{2}fi\frac{1}{2})$ - -	20.46	3.10	6.60	T.
Eudialyte. -	$(m_4zr_2si_{12})o_{18}$ - $(m = na_{1\cdot5}ca_{1\cdot5}fe_{1\cdot0})$	20.30	3.00	6.76	R.
Wöhlerite. - -		....	3.41	...	C.
Humboldtilite.	$(ca_3al_2si_5)o_{10}$ - - - - - - -	19.30	2.90	6.65	T.
Ilvaite. - - -	$(m_3fi_2si_5)o_{10}$ - $(m = fe\frac{2}{3}ca\frac{1}{3})$ - -	22.83	3.71	6.15	O.
Gehlenite. - -	$(ca_{1\cdot0}m_{1\cdot0}si_{1\cdot3})o_{3\cdot3}$ - $(m = al\frac{5}{6}fi\frac{1}{6})$	19.83	3.06	6.48	T.
Sarcolite - -	$(ca_1al_1si_2)o_4$ - - - - - - - -	18.75	2.93	6.40	T.
Milarite. - -	$(m_1al_1si_8)o_{10}$ - $(m = ca_{0\cdot8}k_{0\cdot2})$ -	16.88	2.59	6.51	O.
Barylite. - -	$(ba_2al_3si_7)o_{12}$ - - - - - - -	25.75	4.03	6.38	?
Meionite. - -	$(ca_4al_9si_{12})o_{25}$ - - - - - - -	17.80	2.74	6.49	T.
Wernerite. -	$(m_4al_9si_{16})o_{29}$ - - - - - - -	17.41	2.70	6.44	T.
Ekebergite. -	$(m_4al_9si_{18})o_{31}$ - - - - - - -	17.42	2.74	6.32	T.
Mizzonite. -	$(m_4al_9si_{21})o_{34}$ - - - - - - -	17.20	2.62	6.56	T.
Dipyre. - - -	$(m_4al_9si_{24})o_{37}$ - - - - - - -	16.89	2.64	6.39	T.
Marialite. - -	$(m_4al_9si_{36})o_{49}$ - - - - - - -	16.43	2.57	6.39	T.
Sodalite. - -	$(na_4al_9si_{12})o_{24}cl_1$ - - - - - -	19.88	2.30	8.28	I.
Nosite. - - -	$(na_1al_3si_4)o_8 + \frac{1}{3}na_1s_1o_4$ - - -	20.28	2.40	8.25	I.
Hauÿne. - -	$(na_1al_3si_4)o_8 + \frac{2}{3}ca_1s_1o_4$ - - -	21.60	2.50	8.64	I.
Lapis lazuli. -	- - - - - - - - - - - - -	....	2.45	...	I
Leucite. - -	$(k_1al_3si_8)o_{12}$ - - - - - - - -	18.16	2.56	7.09	I.
Hyalophane. -	$m_1al_3si_8)o_{12}$ - $(m = ba\frac{1}{2}k\frac{1}{2})$ - -	19.39	2.80	6.92	C.
Orthoclase. -	$(k_1al_3si_{12})o_{16}$ - - - - - - -	17.37	2.54	6.83	C.
Microcline. -	$(k_1al_3si_{12})o_{16}$ - - - - - - -	17.37	2.54	6.83	A.
Nephelite. - -	$(na_1al_3si_{4\cdot5})o_{8\cdot5}$ - - - - - -	17.58	2.66	6.60	H.
Paranthite. -	$(ca_1al_3si_4)o_8$ - - - - - - - -	17.37	2.75	6.31	T.
Eucryptite. -	$(li_1al_3si_4)o_8$ - - - - - - - -	15.75	2.67	5.93	H.
Anorthite. - -	$(ca_1al_3si_4)o_8$ - - - - - - - -	17.37	2.75	6.32	A.
Barsowite. -	$(ca_1al_3si_5)o_9$ - - - - - - - -	17.11	2.73	6.27	?
Labradorite. -	$(m_1al_3si_6)o_{10}$ - $(m = ca\frac{3}{4}na\frac{1}{4})$ -	16.97	2.70	6.28	A.
Andesite. - -	$(m_1al_3si_8)o_{12}$ - $(m = ca\frac{1}{2}na\frac{1}{2})$ -	16.70	2.68	6.23	A.
Oligoclase. -	$(m_1al_3si_9)o_{13}$ - $(m = na\frac{3}{4}ca\frac{1}{4})$ -	16.63	2.65	6.27	A.
Albite. - - -	$(na_1al_3si_{12})o_{16}$ - - - - - - -	16.37	2.62	6.24	A.
Iolite. - - -	$(m_1al_3si_5)o_9$ - $(m = mg\frac{2}{3}fe\frac{1}{3})$ -	16.81	2.67	6.29	H.
Petalite. - -	$(li_1al_4si_{20})o_{25}$ - - - - - - -	15.32	2.42	6.33	C.

9th, since which time he has greatly extended his enquiries in this direction. He finds that while not only the pectolitoids and the zeolitoids, but various spathoids, such as wollastonite, the feldspars and scapolites, as well as iolite and petalite (together with titanite, jefferisite and protovermiculite) are more or less readily corroded by the fluorhydric acid, the adamantoids, pyroxene (diopside) enstatite, danburite, garnet, epidote, zoisite, axinite,

beryl, spodumene, black tourmaline, andalusite, topaz and cyanite, as well as various phylloids, including talc, muscovite, lepidolite, margarite, phogopite, and ripidolite, are not attacked by this reagent. It may be added that datolite, which in the tables we have placed among Pectolitoids, appears, from its great condensation and its comparative indifference to the action of fluorhydric acid, to belong to the Protadamantoids.

§ 10. Pursuing farther this interesting path of investigation, Mr. Mackintosh has, at my suggestion, determined the relative rate of attack, by experiments on equal weights of various native silicates reduced to grains of uniform size and exposed to the action of

TABLE VIII.—PROTOPERADAMANTOIDS.

SPECIES.	FORMULA.	P	D	V	X
Pargasite. -	$(m_2al_1si_3)o_6$ - $(m = ca_{0\cdot5}mg_{1\cdot5})$ -	17.60	3.05	5.79	C.
Keilhauite.	$(m_2m_1si_4ti_3)o_{10}$ - - - - - - -	...	3.72	...	C.
Schorlomite.	$(ca_4fi_3si_6ti_4)o_{17}$ - - - - - -	21.41	3.80	5.63	?
Idocrase. -	$(ca_3al_2si_5)o_{10}$ - - - - - - - -	19.30	3.40	5.67	T.
Garnet. -	$(ca_1al_1si_2)o_4$ - - - - - - - -	18.75	3.50	5.37	I.
Allanite. - -	$(m_1al_1si_2)o_4$ - $(m = ce\frac{1}{3}ca\frac{1}{3}fe\frac{1}{3})$	21.67	4.00	5.42	C.
Ægirite. -	$(m_3fi_3si_{12})o_{13}$ - $(m_3 = na_1ca_1fe_1)$	19.72	3.58	5.50	C.
Beryl. - -	$(be_3al_3si_{12})o_{18}$ - - - - - - -	14.92	2.70	5.52	H.
Euclase. -	$(be_2al_3si_4)o_9 + 1aq$ - - - - - -	14.50	3.10	4.67	C.
Arfvedsonite.	$(m_2fi_3si_{10})o_{15}$ - $(m_2 = na_1ca_1)$ -	19.26	8.59	5.33	C.
Ardennite.	$(mn_2al_3si_4)o_9 + 1aq$ - - - -	...	3.62	...	O.
Axinite. -	$(ca_1m_2si_{3\cdot5}bo_{0\cdot5})o_7$ - $(m_2 = al\frac{4}{3}fi\frac{2}{3})$	18.11	3.27	5.53	A.
Epidote. -	$(ca_1m_2si_3)o_6 + \frac{1}{3}aq$ - $(m_2 = al\frac{4}{2}fi\frac{2}{3})$	18.38	3.40	5.40	C.
Zoisite. - -	$(ca_1al_2si_3)o_6$ - - - - - - - -	17.83	3.35	5.32	O.
Jadeite. -	$(na_1al_2si_6)o_9$ - - - - - - - -	16.88	3.32	5.08	?
Gastaldite.	$(m_1al_2si_6)o_9$ - - - - - - - -	17.08	3.04	5.61	C.
Glaucophane.	$(m_3al_2si_8)o_{13}$ - - - - - - - -	17.57	3.12	5.63	C.
Prehnite. -	$(ca_2al_3si_6)o_{11} + 1aq$ - - - - -	16.66	2.95	5.64	O.
Acmite. -	$(m_2fi_4si_{12})o_{18}$ - $(m_2 = na_{1\cdot5}fe_{0\cdot5})$ -	19.50	3.53	5.52	C.
Spodumene.	$(li_1al_4si_{10})o_{15}$ - - - - - - -	15.53	3.18	4.88	C.
Sapphirine.	$(mg_1al_4si_1)o_6$ - - - - - - - -	17.16	3.48	4.90	O.
Staurolite.	$(fe_1al_4si_{2\cdot5})o_{7\cdot5} + \frac{1}{3}2q$ - - - -	18.45	3.75	4.92	O.
Coronite. -	$(m_1al_3si_5)o_9$ - - - - - - - -	16.36	3.05	5.36	R.
Schorlite. -	$(m_1al_4si_6)o_{11}$ - - - - - - - -	16.68	3.10	5.38	R.
Aphrizite. -	$(m_1al_6si_8)o_{15}$ - - - - - - - -	17.24	3.20	5.38	R.
Indicolite.	$(m_1al_9si_{12})o_{22}$ - - - - - - -	16.42	3.08	5.33	R.
Rubellite. -	$(m_1al_{12}si_{15})o_{28}$ - - - - - -	16.06	3.00	5.35	R.

an excess of dilute fluorhydric acid. This, with a strength of nine per cent., was found to dissolve in one hour's time, of 100.00 parts of albite, 23.00 parts; of petalite, 28.97; of iolite, 47.34; of orthoclase 43.45; and of leucite 66.30 parts; while of chrysolite but 5.40, and of quartz but 1.56 parts were dissolved. Of opal, under similar conditions, 77.68, and of a yellowish noble serpentine (specific gravity = 2.532) 80.67 parts were dissolved, showing a great susceptibility of these colloid or porodic species to the action of the acid solvent. Labradorite and oligoclase are, like the other feldspars, readily attacked, but the separation of an insoluble calcium-fluorid was found to be a disturbing factor in quantita-

tive experiments upon these and other soluble lime-holding silicates. The influence of other bases, and the varying proportions of these will, probably, on farther investigation, be found of significance. Instead of a constant quantity of the various silicates compared, this might be varied with the unit-weights of the several species, which are, for example, for albite, 16.37; for orthoclase, 17.37; and for leucite, 18.16.

TABLE IX. — PROTOPERPHYLLOIDS.

SPECIES.	FORMULA.	P	D	V	X
Astrophyllite. -	$(m_5 m_2 si_{10})o_{17}$ - - - - - - - - - -	...	3.32	...	O.
Phlogopite. - -	$(m_4 al_2 si_6)o_{12}$ - $(m_4 = mg_{3\cdot5} k_{0\cdot5})$ - -	18.12	2.85	6.35	O.
Pyrosclerite. - -	$(mg_4 al_2 si_6)o_{12} + 3aq$ - - - - - -	15.40	2.74	5.62	O.
Penninite. - -	$(mg_{4\cdot0} al_{2\cdot0} si_{4\cdot5})o_{10\cdot5} + 3aq$ - - - -	15.40	2.67	5.76	R.
Ripidolite. - -	$(mg_5 al_3 si_6)o_{14} + 4aq$ - - - - - -	15.38	2.70	5.70	C.
Prochlorite. - -	$(m_4 al_3 si_{4\cdot66})o_{11\cdot66} + 3aq$ - $(m_4 = mg_2 fe_2)$	17.72	2.96	5.98	H.
Leuchtenbergite.	$(mg_{4\cdot5} al_{3\cdot0} si_{5\cdot0})o_{12\cdot5} + 3\frac{1}{2}aq$ - - - -	15.46	2.65	5.83	H.
Venerite. - - -	$(m_4 m_3 si_6)o_{13} + 4aq$ - - - - - -	16.84	...	...	?
Corundophilite. -	$(m_4 al_4 si_4)o_{12} + 3\frac{1}{3}aq$ - $(m_4 = mg_3 fe_1)$	15.20	2.90	5.21	C.
Biotite. - - - -	$(m_4 m_4 si_8)o_{16}$ - $(m_4 = mg_{3\cdot5} k_{0\cdot5})$ - -	18.18	3.00	6.06	H.
Voigtite. - - -	$(m_4 m_4 si_8)o_{16} + 4aq$ - $(m_4 = mg_3 fe_1)$ -	16.48	2.91	5.66	?
Cryophyllite. -	$(m_3 al_4 si_{14})o_{21}$ - $(m_3 = fe_1 k_1 li_1)$ - -	17.90	2.91	6.15	O.
Seybertite. - -	$(m_6 al_9 si_5)o_{20} + \frac{1}{2}aq$ - $(m_6 = mg_4 ca_2)$ -	17.97	3.15	5.70	O.
Thuringite. - -	$(fe_6 m_9 si_9)o_{24} + 6aq$ - $(m_9 = al_6 fi_3)$ -	19.56	3.19	6.13	?
Jefferisite. - - -	$(mg_6 m_9 si_{15})o_{30} + 7\frac{1}{2}aq$ - $(m = al_6 fi_3)$ -	14.92	2.30	6.50	O.
Annite. - - - -	$(m_6 m_{12} si_{18})o_{36}$ - $(m_6 = fe_4 k_2)$ - - -	20.84	3.17	6.57	?
Willcoxite. - -	$(m_6 al_{12} si_{10})o_{28} + 2aq$ - $(m_6 = mg_5 na_1)$	16.76	...	...	?
Chloritoid. - -	$(fe_1 al_3 si_2)o_6 + 1aq$ - - - - - -	18.00	3.55	5.07	C.
Lepidomelane. -	$(m_1 m_3 si_4)o_8$ - - - - - - - - -	...	3.00	...	H.
Zinnwaldite. - -	$(m_1 al_3 si_6)o_{10}$ - $(m = k_{0\cdot5} li_{0\cdot5})$ - - -	17.20	3.00	5.73	O.
Oellacherite. - -	$(m_1 al_3 si_6)o_{10} + 1aq$ - $(m = k\frac{1}{4} ba\frac{1}{4} mg\frac{1}{2})$	17.33	2.99	5.79	?
Lepidolite. - -	$(m_{1\cdot0} al_{4\cdot5} si_{8\cdot0})o_{13\cdot5}$ - $(m = k_{0\cdot5} li_{0\cdot5})$ -	16.85	3.00	5.61	O.
Margarite. - -	$(ca_1 al_6 si_4)o_{11} + 1aq$ - - - - - -	16.58	2.99	5.54	O.
Euphyllite. - -	$(m_1 al_8 si_9)o_{18}$ - $(m = k_{0\cdot33} na_{0\cdot66})$ - -	17.07	3.00	5.69	?
Cookeite. - - -	$(m_1 al_{10} si_9)o_{20} + 5\frac{1}{2}aq$ - $(m = li_{0\cdot75} k_{0\cdot25})$	14.80	2.70	5.48	?
Muscovite. - -	$(k_1 al_6 si_9)o_{16}$ - - - - - - - - -	17.75	3.12	5.68	O.
Muscovite. - -	$(k_1 al_6 si_9)o_{16} + 2aq$ - - - - - -	16.77	2.85	5.88	O.
Muscovite. - -	$(k_1 al_9 si_{12})o_{22}$ - - - - - - - - -	17.27	...	...	O.
Damourite. - -	$(k_1 al_9 si_{12})o_{22} + 2aq$ - - - - - -	16.58	2.79	5.94	O.
Muscovite. - -	$(k_{0\cdot5} al_{6\cdot0} si_{9\cdot0})o_{15\cdot5}$ - - - - - - -	16.80	...	...	O.
Muscovite. - -	$(k_{0\cdot5} al_{6\cdot0} si_{9\cdot0})o_{15\cdot5} + 2aq$ - - - -	15.91	2.75	5.78	O.

§ 11. Recent experiments with quartz crystals and sections of crystals show that while the crystalline planes are not visibly attacked by a strong acid of 54 per cent., cut and polished surfaces are corroded, their loss of weight in an hour's time amounting in some experiments to five and six milligrams for the square centimetre of surface. The whole subject of the action of fluorhydric acid on mineral species, now under investigation, promises, in the hands of Mr. Mackintosh, who is both a skillful chemist[1] and a

[1] A brief preliminary statement of his observations appears from the pen of Mr. Mackintosh (now of Lehigh University, Bethlehem, Pennsylvania) in the School of Mines Quarterly for July, 1886, p. 364.

mineralogist, to yield very important results for the science of mineralogy. His experiments appear, as will be seen, to show close relations between this solvent action of the acid and the condensation or atomic volume of the species, as calculated in the accompanying tables of the various tribes of silicates.

TABLE X. — PINITOIDS.

SPECIES.	FORMULA.	P	D	V
Jollyte. - - -	$(m_1al_2si_3)o_6 + 2aq$ - $(m = fe_{0\cdot6}mg_{0\cdot4})$	15.75	2.61	6.03
Fahlunite. - -	$(m_1al_3si_5)o_9 + 1aq$ - $(m = fe\frac{1}{3}mg\frac{2}{3})$ -	16.03	2.70	5.93
Esmarkite. -	$(m_1al_3si_5)o_9 + 2aq$ - - - - - -	15.39	...	...
Bravaisite. -	$(k_1al_3si_9)o_{18} + 4aq$ - - - - - -	15.82	...	...
Hygrophilite.	$(k_1al_3si_9)o_{15} + 3aq$ - - - - - -	16.33	...	...
Pinite. - - -	$(k_1al_8si_{12})o_{24} + 3aq$ - - - - - -	16.25	2.80	5.08
Cossaite. - -	$(na_1al_9si_{12})o_{22} + 2aq$ - - - - -	15.91	2.89	5.50

§ 12. It is not enough to have arranged mineral species in orders and tribes. It is evident that there are relations between certain species in any given tribe which serve to bring them together into families and genera, but which, with our present trivial nomenclature, can be but very imperfectly indicated. The various tourmalines, with different quantivalent ratios, will constitute, at least, one genus, with several species; and the great tribe of the Protoperphylloids includes many genera and more than one family. In

TABLE XI. — PERADAMANTOIDS.

SPECIES.	FORMULA.	P	D	V	X
Dumortierite. -	$(al_2si_1)o_3$ - -	16·33	3·36	4·86	C.
Andalusite. - -	$(al_3si_2)o_5$ - -	16·20	3·35	4·83	O.
Fibrolite. - - -	$(al_3si_2)o_5$ - -	16·20	3·35	4·83	C.
Topaz. - - - -	$(al_3si_2)o_4fl_1$ -	18·40	3·65	5·04	O.
Cyanite. - - -	$(al_3si_2)o_5$ - -	16·20	3·66	4·42	A.
Bucholzite. - -	$(al_3si_3)o_6$ - -	16·00	3·24	4·90	C.
Xenolite. - - -	$(al_3si_3)o_6$ - -	16·00	3·58	4·46	C.
Wörthite. - - -	$(al_6si_5)o_{11} + 1aq$	15·50	....	....	C.
Lyncurite. - -	$(zr_1si_1)o_2$ - -	22·75	4·05	5·61	T.
Malacone. - - -	$(zr_1si_1)o_2 + \frac{1}{4}aq$	21·22	4·00	5·30	T.
Zircon. - - - -	$(zr_1si_1)o_2$ - -	22·75	4·70	4·84	T.
Auerbachite. - -	$(zr_2si_3)o_5$ - -	21·20	4·06	5·22	T.
Anthosiderite. -	$(fi_1si_3)o_4 + \frac{1}{3}aq$	17·21	3·00	5·73	?

the Protoperspathoid tribe, the large family of the feldspathides takes in several genera, one of them the true feldspars, embracing the albite-anorthite series, and perhaps paranthite and iolite; and another, the adularia series, with a less condensation, comprehending orthoclase, microcline and hyalophane. In this same tribe, besides the scapolite genus, which takes in the meionite-marialite series, is a group of related species, including

melilite, humboldtilite, gehlenite, sarcolite, milarite and barylite, which may well constitute a cognate genus. It is only by a binominal nomenclature, such as is employed in other departments of natural history, and has been so often essayed in mineralogy, that generic and specific relations, like those just pointed out, can be properly indicated. Such a nomenclature, in the Latin language, in connection with the system of classification proposed in this, and in the paper to which it is a supplement, would, it is believed,

TABLE XII. — PERPHYLLOIDS.

SPECIES.	FORMULA.	P	D	V	X
Pholerite . . .	$(al_3si_3)o_6 + 2aq$ . . .	14.25	2.51	5.67	O.
Talcosite . . .	$(al_3si_6)o_{11} + 1aq$ . . .	15.33	2.50	6.13	?
Kaolinite . . .	$(al_3si_4)o_7 + 2aq$ . . .	14.33	2.63	5.44	O.
Pyrophyllite . .	$(al_2si_3)o_7 + \frac{2}{3}aq$ . . .	15.00	2.80	5.35	O.
Pyrophyllite . .	$(al_2si_4)o_5 + \frac{2}{3}aq$ . . .	15.00	2.92	5.13	O.

give to mineralogy a form and a completeness, the want of which has been a great hindrance to its study. The preparation of such a nomenclature by the present writer is now well advanced.

§ 13. We have sought, in the essay on "A Natural System in Mineralogy," and in the earlier papers cited therein, to lay the basis of such a system by showing how the differences in hardness and in specific gravity of mineral species—the first data in the natural-

TABLE XIII. — ARGILLOIDS.

SPECIES.	FORMULA.	P	D	V
Schrötterite. - -	$(al_4si_1)o_5 + 5aq$ - -	12.80	2.15	5.95
Collyrite. - - -	$(al_3si_1)o_4 + 4\frac{1}{2}aq$ -	12.53	2.15	5.83
Allophane. - -	$(al_3si_2)o_5 + 6aq$ - -	12.27	1.89	6.49
Samoite. - - -	$(al_3si_3)o_6 + 5aq$ - -	12.81	1.89	6.66
Halloysite. - -	$(al_3si_4)o_7 + 3aq$ - -	13.80	2.40	5.75
Kaolin. - - - -	$(al_3si_4)o_7 + 2aq$ - -	14.33	...	...
Keramite. - - -	$(al_2si_3)o_5 + 2aq$ - -	13.85	...	...
Wolchonskoite. -	$(cr_2si_3)o_5 + 3aq$ - -	15.33	2.30	6.66
Montmorillonite.	$(al_1si_2)o_3 + 2aq$ - -	13.00	2.04	6.37
Chloropal. - - -	$(fi_1si_2)o_3 + 1\frac{1}{2}aq$ -	15.51	2.10	7.38
Cimolite. - - -	$(al_1si_3)o_4 + 1aq$ - -	14.20	2.30	6.17
Smectite. - - -	$(al_1si_4)o_5 + 4aq$ - -	12.55	2.10	5.97

history method of Werner, Mohs and Jameson—are intimately connected with and dependent upon greater or less complexity of chemical constitution. The arbitrary and imperfect chemical method of Berzelius and his modern followers is thus superseded, and a new chemistry is made the foundation of a natural system of mineralogy, in which the natural-historical and the chemical methods are united and harmonized. The crystallo-

graphic mineralogists have assigned to crystalline individualization, which is but an accident of certain mineral species, a disproportionate importance, and a significance which has often been misleading. Systematic mineralogy includes all inorganic matters, whether gases, liquids or solids, and these latter, whether individualized as crystals or existing in the colloidal or porodic state.

§ 14. The genesis of the various mineral species of the earth's crust has been effected by continuous dynamic and chemic agencies working through successive ages, and has determined the differences met with in the successive groups of neptunian rocks, with their gradations in character, from the ante-gneissic granite down to the youngest crystalline schists and the detrital sediments of still later ages. The same is true of the plutonic rocks of different periods, and the laws which have regulated this terrestrial process are, as we have elsewhere endeavoured to show, not less certain and definite than those of

SUB-ORDER I. — PROTOSILICATE.

m : si.	1. PECTOLITOID. V=7·0—5·3	2. PROTOSPATHOID. V=6·7—6·0	3. PROTADAMANTOID. V=6·0—4·6	5. OPHITOID. V=7·3—5·5
1 : ¾	- - - - - - - - - - -	Danalite (7 : 6). - - - - - - - -	Chondrodite.	
1 : 1	Calamine. Thorite. Cerite. -	Willemite. Knebelite. Batrachite. Tephroite. Gadolinite. Helvite.	Monticellite. Chrysolite. Phenacite. Bertrandite.	
1 : 1¼	Chrysotile. - - - - - -	Leucophanite. - - - - - - - - -	- - - - - - - - - - - -	Serpentine. Retinalite.
1 : 1½	Gyrolite. Friedelite. Pyrosmalite. - - - -	- - - - - - - - - - - - - - -	- - - - - - - - - - - -	Deweylite. Genthite.
1 : 2	Xonaltite. Plombierite. Dioptase - - - - - -	Wollastonite. Tscheffkinite. - - -	Amphibole. Rhodonite. Pyroxene. Enstatite. -	Aphrodite. Cerolite. Chrysocolla.
1 : 2⅔	Pectolite. - - - - - - - -	- - - - - - - - - - - - - - -	Amphibole. - - - - - - -	Spadaite.
1 : 2½	- - - - - - - - - - - -	- - - - - - - - - - - - - - -	- - - - - - - - - - - -	Rensselaerite.
1 : 3	- - - - - - - - - - - -	- - - - - - - - - - - - - - -	- - - - - - - - - - - -	Sepiolite. Glauconite.
1 : 3½	Datolite.			4. PROTOPHYLLOID.
1 : 4	Apophyllite. Okenite. - -	- - - - - - - - - - - - - - -	Guarinite. Titanite.	
1 : 7	- - - - - - - - - - - -	- - - - - - - - - - - - - - -	Danburite.	Thermophyllite (3 : 4). Talc (2 : 5). Talc (2 : 6).

astronomical and of biological evolution. The changes seen in comparing alike the neptunian and the plutonic rocks of succeeding geological periods, mark the steps in the mineralogical evolution of the primeval globe. The differentiation of the first anhydrous mass through crystallization and eliquation, the subsequent intervention of permeating waters, the continuous processes of solution, deposition and segregation, the intervention of atmospheric decay, and of the products of subaerial action, alike upon plutonic and crenitic rocks, and upon the ocean's waters, are all factors in this great mineralogical evolution.

§ 15. The mineralogical differences in the various groups of neptunian rocks, as I wrote in 1878, "are not the result of subsequent and unlike changes which one and the same uncrystalline palæozoic series has suffered in different geographical areas, but on the contrary belong to successive periods in palæozoic or eozoic times. The great divisions of the latter . . . . . present, in ascending order, a progressive change in mineral characters,

the nature of which has been shown; . . . . . thus constituting a veritable passage in time from the granitoid gneiss at the base of the Laurentian, through the intermediate Huronian and Montalban divisions, to the less markedly crystalline schists of the Taconian."[1]

While rejecting, in these terms, the notion of the common palæozoic age of the various and dissimilar groups of crystalline stratified rocks in north-eastern America, still maintained by some partisans of the Huttonian dogma (one of whom speaks of them as representing "grades in metamorphism"), it must not be forgotten that the genesis, by different chemical processes, of certain silicates has been continued under various conditions, through palæozoic and more recent times to our own. This is seen, not only in the generation of pectolitic and zeolitic silicates in the channels of thermal springs, in the deep-sea ooze, and in basic eruptive rocks of later as well as earlier periods, but in the zeolitoid silicates, like hamelite, which I have described as injecting palæozoic crinoids and mollusks;

SUB-ORDER II.—PROTOPERSILICATE.

m : m : si.	6. ZEOLITOID. V = 7·2 — 6·3	7. PROTOPERSPATHOID. V = 8·6 — 6·1	8. PROTOPERADAMANTOID. V = 5·8 — 4·7		9. PROTOPERPHYLLOID. V = 6·2 — 5·1		
1 : ½ : n	- - - - -	Melilite. Eudialyte. -	Pargasite. Keilhauite. - - - - - -		MICAS.	Phlogopite. - CHLORITES.	A large group of hydrous magnenesian species.
1 : ⅔ : n	- - - -	Wöhlerite. Ilvaite. -	Idocrase. Schorlomite (4 : 3). - - -			Phlogopite. -	
1 : 1 : n	Xanthorthite.	Gehlenite. Sarcolite. Milarite. - - - -	Garnet. Ægirite. Allanite. Beryl. -			Biotite. - -	
1 : 1½ : n	- - - - -	Barylite. - - - - -	Euclase. Ardennite. Prehnite. -			Seybertite.	10. PINITOID.
1 : 2 : n	Hamelite. Catapleiite.	Scapolites. Sodalites.	Axinite. Epidote. Zoisite. Jadeite. Gastaldite. Acmite. - - - - -			Willcoxite. -	Jollyte.
1 : 3 : n	ZEOLITES. - -	FELDSPATHIDES. - - -	- - - - - - - - - - -	Coronite.		Zinnwaldite.	Fahlunite. Bravaisite.
1 : 4 : n	Edingtonite. Sloanite.	Petalite. - - - - -	Spodumene. Sapphirine. Staurolite. - - - -	Schorlite.		Lepidolite. -	Hygrophilite (1 : 5).
1 : 6 : n	Forestite. -	- - - - - - - - - -	- - - - - - - - - -	- - - -		Margarite. Muscovite.	Sordavalite.
1 : 8 : n	- - - - -	- - - - - - - - - -	- - - - - - - - - -	Aphrizite.		Euphyllite.	Pinite.
1 : 9 : n	- - - - -	- - - - - - - - - -	- - - - - - - - - -	Indicolite.		Damourite. Muscovite.	Cossaite.
1 : 12 : n	- - - - -	- - - - - - - - - -	- - - - - - - - - -	Rubellite.		Muscovite.	(Palagonite. Tachylite. Pitchstone. Obsidian.)
						(With other species).	

in the glauconite and related species formed from the Cambrian period down to the present day; in the deposition of serpentine in Silurian strata; and in the sepiolite beds of the tertiary period—the results of processes in which solutions like those which have given rise to the crystalline pectolitoids and zeolitoids are supposed to have intervened[2]

§ 16. Neither is the fact to be overlooked that local changes, probably through the intervention of thermal waters, and sometimes, though not always, visibly connected with the intrusion of plutonic rocks, have (as first pointed by me in 1869[3]) effected alike

[1] Hunt's Azoic Rocks, p. 253.

[2] See on the Serpentines of Syracuse, New York, Trans. Roy. Soc. Can., Vol. i. Sec. iii. §§ 27-35; also the Genetic History of Crystalline Rocks, *Ibid.*, Vol. iv. Sec. iii. §§ 1-13.

[3] The Chemistry of the Earth; Report of Smithsonian Institution, 1869. Also Chem. and Geol. Essays, p. 306, and the Origin of Crystalline Rocks, Trans. Roy. Soc. Can., Vol. ii. Sec. iii. §§ 114-116.

the crystalline rearrangement of previously-formed detrital silicates, and the production of new ones, by "the chemical union of heterogeneous elements" present in the sediments—processes in either case resulting in the "local development of crystalline silicates in the texture of clastic rocks." By all of these methods, crystalline species such as quartz, hematite, amphibole, feldspars, garnet, epidote and various micas, as well as serpentine, glauconite and sepiolite, appear occasionally in sedimentary strata, alike of palæozoic and of more recent times. The occurrence of these, and of other species, under such conditions has helped to sustain the arguments of those who imagine a very different action from these, resulting in the complete transformation of ordinary detrital rocks, such as sands and clays, by some metasomatic process, into typical granites, gneisses, and hornblendic and micaceous schists. Of this doctrine of unexplained and inexplicable transmutations, through which isolated portions of earthy sediments of later periods are supposed to have been changed into various types of crystalline schists, which in certain areas are indistinguishable from those of earlier eozoic times, it need only be said that the

SUB-ORDER III. — PERSILICATE.

$m : \dot{S}\dot{i}$.	11. PERZEOLITOID. V = ——	12. PERSPATHOID. V = 7·7—7·2	13. PERADAMANTOID. V = 5·7—4·4	14. PERPHYLLOID. V = 6·1—5·1	15. ARGILLOID. V = 6·5—5·4
1 : ¼	- - - - - - - -	- - - - - - - -	- - - - - - - - - - - - - -	- - - - - - - - -	Schrötterite.
1 : ⅓	- - - - - - - -	- - - - - - - -	Dumortierite. - - - - - - - -	- - - - - - - - -	Collyrite.
1 : ⅔	- - - - - - - -	- - - - - - - -	Topaz. Andalusite. Fibrolite. Cyanite. Wörthite (6 : 5). -	- - - - - - - - -	Allophane.
1 : 1	Westanite. - - -	Bismutoferrite. Eulytite.	Bucholzite. Xenolite. Lyncurite. Zircon. Malacone.	Pholerite. Talcosite (5 : 6).	Samoite.
1 : 1⅓	- - - - - - - -	- - - - - - - -	- - - - - - - - - - - - - -	Kaolinite. - - - -	Kaolin. Halloysite.
1 : 1½	- - - - - - - -	- - - - - - - -	Auerbachite. - - - - - - - -		Hisingerite.
1 : 2	- - - - - - - -	- - - - - - - -	- - - - - - - - - - - - - -	Pyrophyllite. - - -	Keramite. Wolchonskoite.
1 : 2½	- - - - - - - -	- - - - - - - -	- - - - - - - - - - - - - -	Pyrophyllite. - - -	Montmorillonite. Chloropal.
1 : 3	- - - - - - - -	- - - - - - - -	Anthosiderite. - - - - - - - -	- - - - - - - - -	Cimolite.
1 : 4	- - - - - - - -	- - - - - - - -	- - - - - - - - - - - - - -	- - - - - - - - -	Smectite.

supposed examples of it have, one by one, been disproved and abandoned by their former advocates. The whole doctrine of regional metamorphism, as maintained by Huttonians, was an attempt to substitute the intervention of miracles for the established order of mineralogical development.[1]

§ 17. In discussing, in the essay on a Natural System in Mineralogy, the question of the chemical constitution and the different degrees of condensation in mineral species, in connection with the doctrines of high equivalent weights and polymerism, which are there maintained, we have, in deference to the general usage of chemists, employed the terms "molecular weight" and "molecular volume," although they are in contradiction to our own conceptions of the philosophy of chemistry. Moreover, while therein asserting that liquids and solids are polymers of gaseous species, and their equivalent weights consequently multiples of the unit-weights deduced from chemical analysis and vapor-density, we have said the "molecular weights of these are as yet unknown," and moreover,

[1] The succeeding portions of this paper were not communicated till August, 1886.

"the relations of this unit-weight and unit-volume to those of the molecule to which it belongs are unknown." It was not at the time of writing the above essay, apparent to the author, that the principles laid down elsewhere in its pages, and first enunciated more than thirty years earlier, necessarily lead to a simple solution of the problem of these unknown relations, and of that presented by the distinction between what has been designated "the chemical molecule" and the "molecule of the physicist." As already stated by the author in 1853, the solution of these questions is to be found in the discovery of "a definite and constant relation . . . . . between its vapor-density and the specific gravity of a species in its solid state," so that "the volume of the condensation in passing from a gaseous to a solid state being known, the equivalents of solids, like those of vapors, might be determined from their specific gravities." It was farther maintained that "all species crystallizing in the same shape have the same equivalent volume, so that their equivalent weights, as in the case of vapors, are directly as their densities." Misled by the notions then current, the author failed to attain the conception of the volume as a constant quantity, and hence wrote that "the atomic volumes of crystallized species are the comparative volumes of their crystals." The true conception of the meaning of volume was, however, embodied in his assertion, made at the same time, that "the doctrine of chemical equivalents is that of the equivalency of volumes," and in his declaration that "the simple relations of volumes which Gay Lussac pointed out in the chemical changes of gases apply to all liquid and solid species," so that "the application of the atomic hypothesis to explain the law of definite proportions becomes wholly unnecessary." "These views", it was then said, "will be found to enlarge and simplify the plan of chemical science," and they were at the same time farther characterized as "principles which may serve as the basis of a sound theory of chemistry."

§ 18. The subject thus set forth in 1853, was farther discussed in 1867, when it was asserted that "the gas or vapor of a volatile body constitutes a species distinct from the same body in a liquid or solid state, the chemical formula of the latter being some multiple of the first; and the liquid and solid species themselves often [probably always] constitute two distinct species of different equivalent weights." [1] From this it follows that freezing, melting and vaporization are chemical changes. The union of many volumes of vapor or gas, in a single volume of a liquid or a solid, is a process of chemical combination, while vaporization is chemical decomposition. Such decomposition is either with or without specific difference, and examples of these two modes are seen respectively in heterogeneous decomposition, and in integral volatilization, which latter is the breaking up or dissociation of a polymeric species into simpler forms having the same centesimal composition. Both of these processes are subordinated to the same laws of pressure and temperature, and involve similar thermic changes in the relations of the bodies concerned. In this enlarged conception of the chemical process we find a solution of the problems above proposed, and an explanation of the distinction which has been drawn between "the chemical molecule" and "the molecule of the physicist." That the latter has a much less simple constitution than the former, as calculated from the results of chemical analysis and from vapor-den-

[1] On the Theory of Chemical Changes and Equivalent Volumes, Amer. Jour. Sci., March 1853; L. E. & D. Philos. Mag. [4] V. 536, and in a German translation in the Chemisches Centrablatt for 1853 (p. 849); reprinted in Hunt's Chem. and Geol. Essays, pp. 426-437; where also will be found (pp. 453-458) the paper of 1867, quoted above, on the Objects and Method of Mineralogy, from the American Journal of Science for May, 1867.

sity, has been maintained alike on dynamical and on chemical grounds from the time of Favre and Silbermann in 1847, to that of Louis Henry and of Spencer Pickering in 1885, and was taught by the writer in 1853, in the essay already quoted.

§ 19. If then, as maintained by the writer since 1853, "the doctrine of chemical equivalents" is reducible to that of "the equivalency of volumes," and applies not only to "the chemical changes of gases" but "to all liquid and solid species;" if the production of these by the condensation of vapors is a chemical process giving rise to polymers, the equivalent weights of which are as much more elevated as their densities are greater than those of the vapors which combine to form them, it would seem, as has already been said, that the application of the atomic hypothesis to explain the law of definite proportions and the chemical process becomes not only unnecessary but misleading. According to this hypothesis, which conceives molecules to be built of atoms, and masses of molecules, the different ratios in unlike species between the combining weight of the chemical unit or molecule (as deduced from the chemical analysis and from the vapor-density), and the specific gravity of the mass, are supposed to represent the relative dimensions of the molecules. Hence, the values got by dividing these combining weights by the specific gravity have been called "molecular volumes." The number of such chemical molecules required to build up a physical molecule of constant volume would, according to this hypothesis, be inversely as their size. If, however, as all the phenomena of chemistry show, the formation of higher and more complex species is by condensation, or, in other words, by identification of volume, and not by juxtaposition, it follows that the so-called molecular volumes are really the numbers representing the relative amount of contraction of the respective substances in passing from the gaseous to the liquid or solid state, and are *the reciprocals of the coefficients of condensation of the assumed chemical units.*

§ 20. Thus, when steam at 100° and 760 millimeters pressure, with a formula, as deduced from its density, of H_2O, and a combining weight of 18, (H = 1) is converted into water of the same temperature, 1,628 volumes of it are condensed into a single volume, having a specific gravity of 0.9588, which at 4 becomes 1.0000. Water is thus 1,628(H_2O), and the weight of its volume at the temperature of formation as compared with an equal volume of hydrogen gas—in other words its equivalent weight—is $1,628 \times 18 = 29,304$ (or 29,244 if $H_2O = 17.9633$), which corresponds to a specific gravity of 1.0000 at 4°. The hydrocarbon $C_4H_{10} = 58$, condenses to a liquid having an observed density of 0.600, which corresponds to an equivalent weight, as compared with that of water, of 17,516, or approximately 303(C_4H_{10}), but while the reciprocal of condensation (or so-called molecular volume) of water = 18, that of the liquid hydrocarbon is 600 : 1000 : : 58 : 96⅔, which value, multiplied by the co-efficient, 303 = 29,251; the calculated density being 0.599. The chemical unit or so-called molecule for both of these species is fixed by the density of their vapor.

§ 21. If now for calcite, which is not volatilized but undergoes heterogeneous decomposition by heat, we assume, as the chemical unit, $CCaO_3 = 100$, with a specific gravity of 2,735, we find for its so-called molecular volume, or reciprocal of condensation, $100 \div 2.735 = 35.56$. The combining weight of calcite as deduced from this specific gravity is 79,922, which gives for calcite the formula $800(CCaO_3) = 80,000$, while $800 \times 35.56 = 29,248$, very nearly the equivalent weight of water. The specific gravity of some of the purest forms of calcite is, according to Breithaupt, 2.74, and upwards; it is not impro-

bable that the lower densities found for some other calcites may correspond to isomeric species with smaller coefficients of condensation. Aragonite has the formula $860(CCaO_3) = 86{,}000$, with a calculated specific gravity of 2,934.

Differences in specific gravity like those seen between the isomeric species, calcite and aragonite, appear in the hydrocarbons of the terpene group, which, with a common centesimal composition, constitute several species differing widely in specific gravity and in boiling point, but interconvertible. Analogous differences in specific gravity and in boiling point are noticed in the isomeric propylic and butylic alcohols, and correspond to greater or less degrees of condensation.

§ 22. From the above principles, we find:—

I. The equivalent weight for liquids and for solids, as for gases, varies directly as the density, so that having determined this weight for water (which is here made the unit of density for gases as well as for liquids and solids) we are enabled to calculate it for any species the density of which is known.

II. The value of the chemical unit being either fixed experimentally, as in the case of vapors, or assumed, as in the case of non-volatile species, we, from the equivalent weight of the species, determine the coefficient of the condensation therein.

III. The value got by dividing the equivalent weight of the chemical unit by the density of the species, is the reciprocal of the coefficient of condensation of that unit; being called, in the language of the molecular hypothesis, the volume of the chemical unit or molecule.

VII.—*On Some Canadian Minerals.*

By B. J. HARRINGTON, B.A, PH.D., F.G.S.

(Read May 26, 1886.)

I.—SODALITE.

The mineral sodalite, though not the only silicate containing chlorine, is interesting on account of the considerable proportion of that element which it holds. Its occurrence in Canada was first noticed by Dr. Hunt, who, many years ago, detected it in small quantity in the nepheline-syenite (*granitoid trachyte* of Hunt) of Brome Mountain. Subsequently it was found by the writer in some of the nepheline-syenites of Montreal and Belœil, and more recently it has been discovered by Dr. G. M. Dawson on the Ice River, a branch of the Beaver Foot River, near Kicking Horse Pass, in the Rocky Mountains.

The mineral from Montreal was described by the writer in 1875, and lately that from the Rocky Mountains has been examined. In both cases the results of analysis agree closely with the formula $3Na_3Al_2Si_2O_8 + 2NaCl$, and are as follows :—

CONSTITUENTS.	MONTREAL.	ICE RIVER.	FORMULA.
Silica	37.52	37.50	37.1
Alumina	31.38	31.82	31.7
Ferric oxide	tr.	0.01	....
Lime	0.35	.....	....
Magnesia	tr.	.....	....
Soda	19.12	19.34	19.2
Potash	0.78	0.27	....
Sodium	4.48	4.61	4.7
Chlorine	6.91	7.12	7.3
TOTAL	100.54	100.67	100.0
Specific Gravity	2.220	2.293	....

Both varieties are of a fine blue colour, and that from the Rocky Mountains might be employed for the purposes of jewelry. A very beautiful polished specimen of it may be seen in the museum of the Geological Survey at Ottawa. The hardness in each case is 5.5.

The rocks in which the sodalite occurs require further study. One of them is a nepheline-syenite, closely resembling, both macroscopically and microscopically, some of those found near Montreal, while another, in which the sodalite appears to be most abundant, is a grey gneiss-like rock containing a great deal of quartz, and possibly fragmental.

II.—Huronite.

The name "Huronite" was long ago given by Dr. Thomson, of Glasgow, to a mineral which was found in a boulder of diabase on Drummond Island, in Lake Huron, and which was sent to him by the late Dr. Holmes, of Montreal. Thomson regarded it as a new species and published a discription and analysis of it in his "Mineralogy" in 1836.

Dana, in his "Mineralogy," speaks of it as "an impure anorthite-like feldspar," but also includes it with fahlunite, on the authority of Hunt. Its true affinities are evidently with the feldspars, and it may be looked upon as an impure or altered form of anorthite. One of the original specimens from Drummond Island is in the Holmes collection at McGill College, and an examination of this shows that Thomson's description is in several respects incorrect. The hardness, for example, is about $5\frac{1}{2}$ instead of $3\frac{1}{4}$, as stated by Thomson. Instead of being infusible, it is distinctly fusible (F about 5), while it contains alkalies, the presence of which is entirely ignored by Thomson.

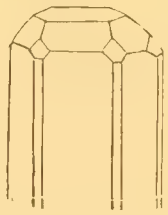
As we have seen, the mineral from Drummond Island was found in boulders, and the origin of these was not known. About two years ago, however, an exactly similar material was discovered *in situ* by Dr. Girdwood near Sudbury, Ontario, where it occurs in rounded or somewhat angular masses in a dark green dyke of diabase, possibly the source of the boulders on Drummond Island. The Sudbury mineral, like that from Drummond Island, is of a light yellowish green colour, shows somewhat indistinct cleavage, and in places, faint striæ, which are probably due to multiple twinning. It is translucent on the edges, and has a rather waxy lustre. The hardness is $5\frac{1}{2}$, or a little over, fusibility about 5, and specific gravity 2.814. Under the microscope, thin sections give evidence of considerable alteration, but with polarized light, the banding due to twinning can be seen in places. An analysis made by Mr. Nevil N. Evans, chemical assistant in the laboratory of McGill College, is given under I., while Thomson's is given under II.—

Constituents.	I.	II.
Silica	47.07	45.80
Alumina	32.49	33.92
Ferric Oxide	0.97	FeO 4.32
Lime	13.30	8.04
Magnesia	0.22	1.72
Potash	2.88	.....
Soda	2.03	.....
Loss on ignition	2.72	4.16
Total	101.68	97.96
Specific gravity	2.814	2.8625

The rock in both cases is a true diabase, although that examined by Thomson was supposed by him to be hornblendic. In each case, the microscope shows the presence of augite, a green chloritic mineral, titanic iron ore, and a more or less decomposed plagioclase, the altered portions of which are probably identical with the so-called "huronite."

III.—Apatite.

Though much has been written with regard to Canadian apatite, little attention seems to have been paid to its crystalline form. In so far as the writer's observation goes, the crystals of most common occurrence consist simply of a combination of the hexagonal prism and pyramid (∞P. P.). A large proportion of the crystals from Renfrew County,



Apatite Crystal from Renfrew, Ontario.

however, exhibit the end-face in combination with the above forms, and resemble the well-known crystals from Snarum in Norway. More rarely, the Renfrew crystals have their vertical edges truncated by the prism of the second order, ∞P2,* while in a few cases, which have recently come under the writer's notice, a pyramid of the second order (2P2) is also present, the full combination in this case being, as shown in the accompanying drawing, ∞P. P. 0P. 2P2. ∞P2.

* Crystals from Bob's Lake, Bedford, Ontario, also show this form.

VIII.—*On some points in reference to Ice Phenomena.*

By ROBERT BELL, B.A.Sc., M.D., LL.D.

(Read May 27, 1886.)

In the following notes it is proposed to recall a few facts in regard to ice phenomena, most of which must be familiar to you all, and to suggest possible explanations of some of these, in the hope of eliciting discussion on a subject which has not yet received the attention it deserves. Some of the geological aspects of these phenomena will also be noticed very briefly. In Canada we have the best opportunities for studying ice in all its aspects, as our country stretches from the comparatively mild climate of Lake Erie, in latitude 42°, to the North Pole, and from the ice-laden North Atlantic on the east, to the warm Pacific on the west. We have every possible condition for the natural display of the phenomena connected with the freezing of water in brooks, and in rivers of the first magnitude, in temperate and in high northern latitudes, in ponds and in lakes of unrivalled extent, on bold and on shallow sea coasts of immense length, on level lands and high mountains; in fact, no other country of the world offers such opportunities for studying this subject.

ICEBERGS.—During the last two summers, the writer, while accompanying the Government expeditions to Hudson Strait, made by the S.S. "Neptune" and "Alert," enjoyed excellent opportunities for observing icebergs, which, for weeks, were the most common objects to be seen from the vessels. Off Labrabor, a stream of bergs, several hundred miles wide and about two thousand miles long, comes constantly southward. These floating islands of ice are more abundant at some seasons than at others, but they are never absent. Upwards of one hundred may often be counted from a ship's deck at the same time. When we consider the mass of each of these innumerable bergs and the constancy with which they come floating on, we must be struck with the almost inconceivable amount of ice which is every year brought to the edge of the Gulf Stream. What becomes of this enormous quantity of ice? Most seamen will tell you it sinks on striking the warm waters. This, of course, is impossible; but the rapid disappearance of the bergs after reaching the Banks of Newfoundland does not seem to have been fully accounted for. Up to this time, they do not appear to have undergone any marked alteration or rapid reduction in size in the course of their voyage southward. When one happens to become stranded on the coast of Labrador or Newfoundland, it will remain for months, even under the summer sun, with but little diminution in bulk, until some day, it starts off again with a high tide, and a strong wind favouring its departure.

The temperature of the interior of icebergs is probably a good deal below 32° Fah. While forming parts of glaciers in the Arctic regions, they have remained for ages at the

low temperature of these high latitudes, and, owing to their great mass, they would gain heat slowly in the short summers. It is well known that each berg is surrounded by a wide zone of cold water, and that, in thick weather, the proximity of one of them to a ship may be discovered by hauling a bucket of water on deck and testing it with a thermometer. As the berg moves south with the ocean current, it carries its chilly zone with it, like a planet surrounded by its atmosphere. The Gulf Stream spreads itself on the surface of the Arctic Current, and towards its edge it is probably not deep. The berg, extending down to a great depth, is borne with comparative rapidity into the opposite-flowing warm surface-current. The zone of very cold water, which until now has remained around the berg, is immediately swept away, exposing its surface suddenly to a temperature, perhaps 30° Fah. warmer than it has ever experienced before. This rapid change would, no doubt, cause the ice to crack and fall to pieces in a very short time. The berg, lightened above, would rise and so bring up new parts of the old ice to be acted upon by the warm water, which would always be increasing in depth. The fresh surface of the fragments of the berg, having the low temperature of its interior, would be immediately acted on in the same way, and these would, in their turn, become fractured over and over again, until the whole mass was reduced to a multitude of small pieces, floating on the surface of the warm water, with warm air above it. As they became scattered about, the process of fracturing, owing to the contrast in temperatures, would continue to go on, and thus every trace of the berg would quickly vanish. In order to test the behaviour of ice at a low temperature when suddenly immersed in warm water, the following experiment was performed in Ottawa on February 27th, 1886. A piece of ice, weighing about ten pounds, which had been freely exposed to the outer air, having then a temperature of −5° Fah., was brought into the house, wrapped in a fur rug, to protect it from the heat, and plunged into a bath of water at a temperature of 87° Fah. Instantly, it began to crack in all directions, with distinct detonations, which could be heard in all parts of the room. In explanation of the fact that icebergs are occasionally met with far south of their usual limit, it may be suggested that these have been retarded by stranding or by gales of wind near the Newfoundland coast until their temperature has been raised; and that then, floating south-westward near the land, they have afterwards been carried out towards mid-ocean by the Gulf Stream.

It is supposed by some that icebergs have been the means of transporting vast quantities of earthy and rocky materials from north to south in former geological times, and that this action is still going on. There does not, however, seem to be much foundation for such speculations. Out of the great number of bergs seen during the two voyages above referred to, only a few had any foreign matter, or even marks of discoloration upon them. It was remarked that towards the entrance to Hudson Strait, cases of the kind were most frequent among the bergs furthest east. In the event of a berg carrying such matter, it would naturally become more visible as the surface melted by the sun's heat on coming south, and if any were present, it should be perceptible by the time the berg reached the latitude of Cape Race; yet, out of the large number which may often be seen from the deck of an Atlantic steamer near this cape, it is very seldom that one is noticed carrying any earth or stones. It would, therefore, appear that icebergs have played only a small part in the transportation of boulders or earth during either Post-Pliocene or modern times.

FIELD-ICE.—This, which we had ample opportunities of observing on the two voyages referred to, appears to be a more important agent in the transport of earthy matter. The northern lands of the Dominion are so divided by the sea as to give an immense length of coast-line. This is all favourable to the formation of the vast quantities of ice which encumber the shores in spring. In many parts where the land is high and steep, quantities of dust and small pieces of rock are blown out upon the ice by the gales in winter. Landslides and avalanches precipitate coarser debris from the steep mountain sides upon the ice below. This is the case, especially, in the long fjords in Northern Labrador. In the spring, earth, gravel and stones are carried upon it by the torrents formed by the melting of the snow. When the sun has loosened this ice sufficiently from the shore, the next spring tide carries it away. In shallow bays, with high tides, such as Ungava Bay, the ice-pans which float in during the autumn and rest against the low shores, become impregnated with the sand and mud, which freeze to the sides at low tide and are incorporated in them as they increase in size during the winter. In the middle of summer, the surface having thawed, the whole of this ice becomes "foxy," as it is termed, or shows discoloration. Many of the pans are completely covered with mud, sand, gravel and stones. Shells and sea-weeds may also be observed on some of them, and all have received more or less dust, which generally gives them a brownish or grayish color. When a pan is suddenly overturned, this gives rise to a dense cloud in the clear sea water. Field-ice would therefore appear to be a more important agent in transporting earthy matter than icebergs. It has been imagined by some that the smoothing and rounding of the rocks, which may often be observed on the shores of the Arctic and sub-Arctic regions, is largely due to a chafing action of ice of this class. There seems to be little ground, however, for this assumption. When the field-ice packs against the shore, it is seldom tossed by the waves of the sea, which are entirely broken down by a comparatively narrow field; so much so, that the sealing vessels are accustomed to run into such ice for shelter, and after they have penetrated a short distance, they are considered safe. Ice of this kind does not shove or pile itself on shore, pushing up the boulders and gravel in front of it, like the ice of our rivers when they break up in the spring. On the contrary, it always appears to lie quietly and easily against the shore. This is probably owing to the fact that the open spaces between the pans allow of a great amount of compression and adjustment, thus relieving the pressure, which is seldom directly towards the land. Indeed, it sometimes happens that the ice will unaccountably leave the shore against the wind.

Dr. Franz Boas of Berlin has observed that in Baffin Land the accumulation of ice in narrow channels, through which the tide sweeps, increases the strength of the current, which sometimes runs with great velocity. In one place, under such circumstances, he observed that stones, boulders and finer debris were set in motion and bored out what he calls "giant-kettles" in solid granite. Similar kettles were seen at this locality, high above the present sea-level, shewing that the same action had been going on in past ages. This observation recalled to the writer the fact that, more than twenty years ago, he noticed great pot-holes on the top of the high limestone cliffs on the east side of the isthmus separating Manitowaning Bay from South Bay on Manitoulin Island, Lake Huron. The surface of the rock in the vicinity is destitute of soil, but the earth which had accumulated in the bottoms of these pot-holes, supported trees, and these, growing out of the deep pits, presented a very curious appearance.

Frazil (Anchor) Ice.—This species of ice is familiar to almost every one in Canada. It forms, as a spongy mass, in cold weather, on the stones in the bottoms of open rapids, in brooks and rivers, and sometimes under the open water, which is often found at the outlets of lakes. In clear weather, it gathers abundantly around the boulders, and when these rest on other stones or have only a narrow base of support, they are sometimes buoyed up by their icy envelope and floated or rolled away by the force of the current. Boulders of considerable weight have sometimes been known to be lifted by this means.

When the weather becomes milder, or the sky overcast, the frazil rises to the surface or floats off like a mixture of snow and water. Although the water may remain open beneath bridges or over-hanging rocks and large fir trees, frazil is not observed to form in such situations. The cause of the formation of frazil had never been satisfactorily accounted for, so far as the writer is aware, until Dr. Sterry Hunt mentioned to him that he regarded it as due to terrestrial radiation and to be analogous to the formation of hoar-frost on the surface of the ground in clear weather. As long as rapid radiation is going on, the surface of the submerged stones will have a sufficiently low temperature to retain the ice. The chilly water supplies abundant material. In rapids, the surging and churning motion would carry down the coldest water from the surface, probably charged with multitudes of fine ice-crystals, and throw it against the stones in the bottom, thus aiding the process. If this view of its formation be correct, the loosening of the frazil in mild or overcast weather would follow as a consequence—as well as the fact that, so far as we are aware, frazil does not form under obstructions to radiation such as those which have been referred to.

At rapids in small rivers, where the bed of the stream is filled with boulders, the writer has frequently found a narrow and straight channel, sufficient to contain the whole stream at low water, excavated among them by the removal of the boulders. The latter are piled on either side, especially towards the lower end of the current, and they have evidently been buoyed up and rolled out of the bottom of the rapid. Judging from their various stages of weathering, and from the different quantities of moss and lichens growing upon them, these boulders have evidently been deposited along either side of the channel in many different years, showing that the process of excavation has been a gradual one. Some of them look as if they had been newly cast out of the bed of the stream. The phenomena, just described, are particularly observable in the numerous small rivers north of Lakes Huron and Superior and are probably due to the action of frazil.

Long Open Fissures.—These, as occurring in the ice of our rivers and lakes, are familiar to all who have had occasion to drive much on our winter roads. These singular rents sometimes extend for miles, almost in straight lines. They usually make their appearance in the early part of winter, and their original formation is said to be accompanied by a loud report. Once established, they remain open all winter, or are covered with only a thin film of ice, and their width generally increases, until the greatest cold is past. They are often a source of trouble to lumbermen and other travellers on the ice, since wooden bridges require to be thrown across them where they intersect the winter roads, their width being often from five to ten feet. Their formation has been ascribed to sudden changes in the temperature of the air. If this view were correct, we should expect these cracks to open or close with every subsequent rise or fall in the

temperature. In order to test this point, Mr. G. B. Abrey, D. T. S., an accurate scientific observer, a few years ago, undertook, at my request, to make a series of exact measurements of the width of a great ice-crack near his residence at Little Current, on Manitoulin Island. The result was that no change of width corresponding to changes in the temperature of the air was perceptible. It was hardly to be expected that a comparatively thin sheet of ice, resting on water of a uniform temperature, would be affected by changes in the temperature of the air, especially as it is protected from it by a coating of snow. Moreover, if it were a fact that the ice of rivers and lakes expands and contracts to any notable extent with changes in the temperature of the air, we should find a perceptible motion at the shore, wherever the ice-sheet is not relieved by fissures. But no such movement has been detected, and, as we have seen, no variation, due to temperature, takes place in the width of the fissures. What then is the cause of these fissures? This question has not yet been satisfactorily answered, so far as the writer is aware; but it may be suggested that the fissures are due to a falling of the water. They form every winter in the same situations and generally between the extremities of points on opposite sides of the water. A lowering of the wider body of water on each side of the line of the crack, would cause the ice to fall away from this line, and when the tension became sufficiently great, the fissure would form and would continue to widen with the progressive lowering of the water. It is well known that the waters of our large rivers and lakes begin to fall, after the frosts of winter have sealed up all the small tributaries, and that the process goes on until these feeders begin to run again in the spring.

Another point in reference to river-ice may be briefly touched upon. It has been stated that the ice, which remains on some of our rivers for half the year, might exhibit a slight glacier-like tendency to move downward, especially in the centre of the stream. Opposite to the city of Montreal, where the current of the St. Lawrence is swift and the ice forms to a thickness of two feet, the writer tested this point during different winters, by making repeated observations on a series of marks set in straight lines across the river, but no deviation could be detected.

Rings of Boulders.—Around the ponds in the rolling country of the second and third prairie steppes, these constitute a singular feature in the treeless regions of our Northwest Territories. Most of these ponds have uniform basin-shaped bottoms and circular or elliptical outlines. The boulders have been removed from their beds and deposited as rings all around their margins. These phenomena, which must be due to ice, are described in my Geological Report for 1874 (p. 52), where an attempt is also made to account for them. It would appear that, in winter, the ponds freeze to the bottom, incorporating in the ice any boulders which may be there. The central, which is the deepest part of most of these ponds, would be the last to freeze, and any addition to the ice, as the cold increased, would be from water oozing in at this part. All the loss by evaporation, which must be great in this dry climate, would be on the upper surface and around the edges, while all the increase would be on its lower side, especially in the central part. Ponds receiving accessions of water from below, yet shallow enough to freeze to the bottom, have been observed on Hudson Bay to assume a distinct dome shape before spring. This tendency to grow from the centre, together with the expansion of the ice from the intense cold would have the effect of raising the boulders each year and

of moving them little by little from the central point towards the periphery. After the lapse of a sufficient length of time, all the boulders would be deposited around the circumference of the pond, as we see them. It is a curious circumstance that when a large boulder happens to occupy the central point of a pond, it remains undisturbed, while every other boulder is removed.

Dykes of Boulders and Shingle.—These are found at high-water mark around the shores of islands and points in many of our northern lakes of large size which freeze over in winter. They are particularly observable where the water is shallow and the shores low and shelving, as in Lakes Winnipegosis and Manitoba, and St. Martin Lake. Some of the islands in these lakes are completely surrounded by such dykes, which are quite steep on both sides, and have an almost uniform height of about five or six feet. They are clearly due to the shoving of the rafts of ice after it breaks up in the spring, and as these impinge on different parts of the shore of an island in different years, a dyke is at length formed around it. The evidence of recent ice-shoves may be plainly seen here and there every year, the freshly upturned earth and boulders marking the sites of those of the preceding spring. Similar dykes may sometimes be observed around the upper portions of alluvial islands in rivers, and they have been ascribed to human agency by those unfamiliar with their mode of formation.

Perpetually Frozen Soil.—The limit of perpetual frost in Canada appears to be placed too far south. In the banks of our northern rivers, even as far south as the Nelson, it is not uncommon in the middle of summer for a shell of clay to peel off and expose a frozen face of thirty or forty feet in height. This, however, does not imply that the ground in the neighborhood is everywhere frozen to this depth. The bank-face being destitute of snow and exposed to the full force of the winter winds, the frost penetrates into it horizontally to a greater depth than it does vertically from the level surface of the ground—a depth sufficient to preserve the frost all summer. The writer having called Sir Henry Lefroy's attention to this circumstance, he admitted that, owing to the radiation which takes place both vertically and horizontally from steep banks, we may reasonably conclude that the frost penetrates to much greater depths in such situations. In more southern latitudes, the writer has observed two instances in similar positions, in which the ground remained frozen long after it had thawed out everywhere else in the surrounding country. One was near the brink of St. Francis River, at Trenholmville, in the province of Quebec, and the other in a similar situation on the bank of Nipigon River at Red Rock, Lake Superior. In both cases, the discovery was made in digging holes to plant posts for mooring boats, and in each, the circumstance was a matter of surprise to the inhabitants. In the country around York Factory on Hudson Bay, where the soil is, by some, supposed to be perpetually frozen, the swamps are full of water all winter, and the snow even prevents thick ice from forming at the surface. Water escaping from these swamps trickles down the banks of the rivers, even in the middle of winter. The fact that in these regions there is plenty of water under the ice in the small streams, and that the beaver inhabits them as far north as Fort Churchill, would appear to show that the frost does not penetrate to such a depth as to remain throughout the year. A test was made by the writer in the swamps just behind York Factory in August, 1879. A heavy,

smooth and sharply-pointed pole was driven by two men, by repeated plunges, into the soft mud under the vegetable layer to a depth of six feet in a number of places, without in any case encountering a frozen stratum. Ice was seen, however, close to the surface under hammocks of dry peaty matter. The continued descent of the frost into the ground, after the warm weather of spring has set in, is strikingly illustrated at many of the posts of the Hudson's Bay Company. Drains, leading from cellars, etc., and placed at five or six feet beneath the surface, continue to run all winter, but usually in the month of May they become converted into solid prisms of ice.

IX.—*Abel's Forms of the Roots of the Solvable Equation of the Fifth Degree.*

By GEORGE PAXTON YOUNG, University College, Toronto.

(Read May 27, 1886.)

I.—OBJECT OF THE PAPER.

§ 1. Jerrard having shown, by a peculiar application of the method of Tschirnhäus, that every equation can be deprived of its second, third and fourth terms, the problem of the solution of equations of the fifth degree is reduced to that of the solution of the trinomial quintic

$$x^5 + p_4 x + p_5 = 0. \tag{1}$$

When p_4 is zero, the roots of this equation are the five values of $-p_5^{\frac{1}{5}}$. In the "American Journal of Mathematics," (Vol. VII. pp. 170–177) the present writer has demonstrated, that, when p_4 is distinct from zero, the equation does not admit of algebraical solution, unless

$$\left.\begin{aligned} p^4 &= \frac{5\,A^4\,(3-B)}{16+B^2}, \\ \text{and } p^5 &= \frac{A^5\,(22+B)}{16+B^2}. \end{aligned}\right\} \tag{2}$$

This is the criterion of solvability. To solve the equation, assuming that p_4 and p_5 are related as in (2), find λ from the quartic equation

$$\lambda^4 - B\,\lambda^3 - 6\,\lambda^2 + B\,\lambda + 1 = 0. \tag{3}$$

$$\left.\begin{aligned} \text{Put } a &= \frac{-(\lambda^2+1)}{A\,\lambda\,(\lambda-1)}, \\ \text{and } \theta &= \frac{-A^5\,\lambda\,(\lambda-1)^2}{(16+B^2)\,(\lambda+1)\,(\lambda^2+1)}, \end{aligned}\right\} \tag{4}$$

Then the root of equation (1) is

$$x = \theta^{\frac{1}{5}} + a\,\theta^{\frac{2}{5}} + \lambda\,a^2\,\theta^{\frac{3}{5}} - \lambda\,a^3\,\theta^{\frac{4}{5}}. \tag{5}$$

A general form of the roots of solvable equations of the fifth degree was found, though without deduction, among the papers of Abel after his death, and is given in "Crelle's Journal" (Vol. V. p. 336.) Let

$$\left.\begin{aligned} \theta_1 &= p + q\sqrt{(1+e^2)} + \sqrt{\{h\,(1+e^2) + h\sqrt{(1+e^2)}\}} \\ \theta_2 &= p - q\sqrt{(1+e^2)} + \sqrt{\{h\,(1+e^2) - h\sqrt{(1+e^2)}\}} \\ \theta_4 &= p + q\sqrt{(1+e^2)} - \sqrt{\{h\,(1+e^2) + h\sqrt{(1+e^2)}\}} \\ \theta_3 &= p - q\sqrt{(1+e^2)} - \sqrt{\{h\,(1+e^2) - h\sqrt{(1+e^2)}\}} \end{aligned}\right] \tag{6}$$

where p, q, h and e are rational. Also let Q_1 be a rational function of θ_1; Q_2 the same same rational function of θ_2; Q_4 the same rational function of θ_4; and Q_3 the same rational function of θ_3. Then Abel's form for the root of the solvable quintic wanting the second term is

$$Q_1\left(\theta_1^4\theta_2^2\theta_4\theta_3^3\right)^{\frac{1}{5}}+Q_2\left(\theta_2^4\theta_4^2\theta_3\theta_1^3\right)^{\frac{1}{5}}+Q_4\left(\theta_4^4\theta_3^2\theta_1\theta_2^3\right)^{\frac{1}{5}}+Q_3\left(\theta_3^4\theta_1^2\theta_2\theta_4^3\right)^{\frac{1}{5}}. \quad (7)$$

Can the value of x in (5) be thrown into this form? It is the object of the paper to show that it can.

II.– Preliminary Explanations.

§ 2. If s be put for $\frac{4}{B}$, the four values of λ, obtained from equation (3), are

$$\lambda_1=\frac{1}{s}\left[1+\sqrt{(1+s^2)}+\sqrt{\{2(1+s^2)+2\sqrt{(1+s^2)}\}}\right]$$
$$\lambda_2=\frac{1}{s}\left[1-\sqrt{(1+s^2)}+\sqrt{\{2(1+s^2)-2\sqrt{(1+s^2)}\}}\right]$$
$$\lambda_4=\frac{1}{s}\left[1+\sqrt{(1+s^2)}-\sqrt{\{2(1+s^2)+2+(1+s^2)\}}\right]$$
$$\lambda_3=\frac{1}{s}\left[1-\sqrt{(1+s^2)}-\sqrt{\{2(1+s^2)-2\sqrt{(1+s^2)}\}}\right].$$

These expressions, λ_1, λ_2, λ_4, λ_3, circulate. That is to say, the changes that cause λ_1 to become λ_2, cause λ_2 to become λ_4, and λ_4 to become λ_3, and λ_3 to become λ_1. For, in order that λ_1 may become λ_2, we must alter the sign of $\sqrt{(1+s^2)}$, and take the new radical thus produced, viz., $\sqrt{\{2(1+s^2)-2\sqrt{(1+s^2)}\}}$, with the positive sign. To make the same changes on λ_2, we must first express the radical $\sqrt{\{2(1+s^2)-2\sqrt{(1+s^2)}\}}$, which does not occur in that form in λ_1, in terms of the radicals present in λ_1. In fact,

$$\sqrt{\{2(1+s^2)-2\sqrt{(1+s^2)}\}}=\frac{2s\sqrt{(1+s^2)}}{\sqrt{\{2(1+s^2)+2\sqrt{(1+s^2)}\}}}.$$

Therefore $$s\lambda_2=1-\sqrt{(1+s^2)}+\frac{2s\sqrt{(1+s^2)}}{\{2(1+s^2)+2\sqrt{(1+s^2)}\}}.$$

By making the same changes on λ_2 that were made on λ_1, $s\lambda_2$ becomes

$$1+\sqrt{(1+s^2)}-\frac{2s\sqrt{(1+s^2)}}{\sqrt{\{2(1+s^2)-2\sqrt{(1+s^2)}\}}},$$

or, $$1+\sqrt{(1+s^2)}-\sqrt{\{2(1+s^2)+2\sqrt{(1+s^2)}\}},$$

which is the value of $s\lambda_4$. Thus, λ_2 has become λ_4. In like manner, λ_4 becomes λ_3, and λ_3 becomes λ_1.

§ 3. Since θ is, by (4), a rational function of λ, let θ_1, θ_2, θ_4, θ_3, be the values of θ corresponding respectively to λ_1, λ_2, λ_4, λ_3. Then the terms θ_1, θ_2, θ_4, θ_3, must circulate with λ_1, λ_2, λ_4, λ_3. Also, if

$$Q^{-1}=-\lambda^4\theta^1a^{11},$$

Q is, by (4), a rational function of λ. Hence, if the four values of Q, corresponding respectively to λ_1, λ_2, λ_4, λ_3, be Q_1, Q_2, Q_4, Q_3, these expressions, Q_1, Q_2, Q_4, Q_3, circulate with λ_1, λ_2, λ_4, λ_3.

III.—Reduction of the Value of x in (5) to Abel's Form.

§ 4. Taking Q_1, Q_2, etc., as above, it will be found that the value of x in (5) admits of being written

$$Q_1 (\theta_1^4 \theta_2^2 \theta_4 \theta_3^3)^{\frac{1}{5}} + Q_2 (\theta_2^4 \theta_4^2 \theta_3 \theta_1^3)^{\frac{1}{5}} + Q_4 (\theta_4^4 \theta_3^2 \theta_1 \theta_2^3)^{\frac{1}{5}} + Q_3 (\theta_3^4 \theta_1^2 \theta_2 \theta_4^3)^{\frac{1}{5}}. \quad (9)$$

For, as was proved in "Principles of the Solution of Equations of the Higher Degrees" (American Journal of Mathematics, Vol. VII), the separate members of the value of x in (5), namely, $\theta^{\frac{1}{5}}$, $a\,\theta^{\frac{2}{5}}$, $\lambda\, a^2\, \theta^{\frac{3}{5}}$, $\lambda\, a^3\, \theta^{\frac{4}{5}}$, are fifth roots of the four values of θ. That is to say, if a, which, by (4), is a rational fraction of λ, becomes a_1 when λ has the value λ_1,

$$\theta_1^{\frac{1}{5}} = \theta_1^{\frac{1}{5}},\ \theta_2^{\frac{1}{5}} = a_1\, \theta_1^{\frac{2}{5}},\ \theta_3^{\frac{1}{5}} = \lambda_1\, a_1^2\, \theta_1^{\frac{3}{5}},\ \theta_4^{\frac{1}{5}} = -\lambda_1\, a_1^3\, \theta_1^{\frac{4}{5}}. \quad (10)$$

These values of $\theta_1^{\frac{1}{5}}$, $\theta_2^{\frac{1}{5}}$, $\theta_3^{\frac{1}{5}}$, $\theta_4^{\frac{1}{5}}$, give us

$$(\theta_1^4 \theta_2^2 \theta_4 \theta_3^3)^{\frac{1}{5}} = -(\lambda_1^4 \theta_1^4 a_1^{11})\, \theta_1^{\frac{1}{5}}.$$

Therefore, by (8), $\theta_1^{\frac{1}{5}} = Q_1 (\theta_1^4 \theta_2^2 \theta_4 \theta_3^3)^{\frac{1}{5}}$. (11)

As λ_1 runs through the four values λ_1, λ_2, λ_4, λ_3, the expressions θ_1 and Q_1 run through their corresponding values. Hence, from (11),

$$\left.\begin{aligned} \theta_2^{\frac{1}{5}} &= Q_2 (\theta_2^4 \theta_4^2 \theta_3 \theta_1^3)^{\frac{1}{5}} \\ \theta_4^{\frac{1}{5}} &= Q_4 (\theta_4^4 \theta_3^2 \theta_1 \theta_2^3)^{\frac{1}{5}} \\ \theta_3^{\frac{1}{5}} &= Q_3 (\theta_3^4 \theta_1^2 \theta_2 \theta_4^3)^{\frac{1}{5}}. \end{aligned}\right\} \quad (12)$$

But (11), (12) and (10) give us for the value of x the expression in (9). This is Abel's form; only we require to prove that θ_1, θ_2, θ_4, θ_3, have the forms in (6), which are those assigned to them by Abel. Since θ_1 is a rational function of λ_1, its form is

$$\theta_1 = p + k \sqrt{(1+s^2)} + \{m + n \sqrt{(1+s^2)}\} \sqrt{\{2(1+s^2) + 2\sqrt{(1+s^2)}\}}; \quad (13)$$

where p, k, m and n are rational. Put

$$D = m^2 + n^2 (1+s^2) + 2\, m\, n\, (1+s^2)$$
$$\text{and } G = m^2 + n^2 (1+s^2) + 2\, m\, n.$$

$$\text{Then if } e = \frac{s\,\{m^2 - n^2 (1+s^2)\}}{D}, \quad (14)$$

$$\text{and } h = \frac{2\, D^2}{G}, \quad (15)$$

e and h are rational. From (14), keeping in view the values of D and G, we get $D^2 (1+e^2) = G^2 (1+s^2)$; therefore

$$\sqrt{(1+s^2)} = \frac{D}{G} \sqrt{(1+e^2)}. \quad (16)$$

Also, (15) and (16) give us

$$\{m + n\sqrt{(1+s^2)}\} \sqrt{\{2(1+s^2) + 2\sqrt{(1+s^2)}\}} = \sqrt{\{h(1+e^2) + h\sqrt{(1+e^2)}\}}. \quad (17)$$

By means of (16) and (17), (13) becomes

$$\theta_1 = p + \frac{k\,D}{G} \sqrt{(1 + e^2)} + \sqrt{\{h\,(1 + e^2) + h \sqrt{(1 + e^2)}\}}\,;$$

which, by writing q for $\frac{k\,D}{G}$, is Abel's form for θ_1 in (6).

IV.—Numerical Verification.

§ 5. The above results may be readily verified by taking any equation such as (1), with numerical co-efficients related as in (2). The writer has calculated the values of λ_1, λ_2, &c., θ_1, θ_2, etc., a_1, a_2, etc., Q_1, Q_2, etc., in the case of the equation

$$x^5 + \tfrac{625}{4}\,x + 3750 = 0\,;$$

and has found that the separate numbers of the expression for x in (5), when arranged in the order,

$$\theta_1^{\frac{1}{5}},\ a_1\,\theta_1^{\frac{2}{5}},\ -\lambda_1\,a_1^3\,\theta_1^{\frac{4}{5}},\ \lambda_1\,a_1^2\,\theta_1^{\frac{3}{5}},$$

have respectively the values of the separate members of the expression in (9), taken in the order in which they are written in (9).

X.—*A Meteorite from the Northwest.*

By A. P. COLEMAN, Ph. D., Victoria University, Cobourg.

(Presented May 27, 1886.)

Some seventeen years ago, Mr. David McDougall, at the instance of his father, the Rev. George McDougall, brought in, by Red River cart, a mass of meteoric iron, weighing about 386 lbs. It was found on a hill near Iron Creek, a tributary of Battle River, at a point about 150 miles south of Victoria, on the North Saskatchewan. It was sent to Winnipeg, and afterwards to the Mission Rooms in Toronto, and now forms the chief ornament of the Museum of Victoria University.

This meteorite was greatly venerated by the Indians, who made offerings to it of beads, trinkets or knives before setting out on hunting or warlike expeditions. The Indians saw in the markings of its surface the rough features of a face, believed that the "stone" attracted lightning, and that it had grown in size and weight since they first saw it.

In outline, this meteorite is irregularly triangular and much broader than it is thick. Its surface shows the usual rounded and pitted appearance. It consists of solid metal, with scarcely a trace of stony matter, and only a slight oxidation of the surface.

The specific gravity of the metal is 7.784. An analysis gives the following results:—

Iron	91·33 per cent.
Nickel	8.83 " "
Cobalt	0.49 " "
TOTAL	100.65

To illustrate Mr. Sandford Fleming's paper entitled "Time-Reckoning for the Twentieth Century."

ROYAL SOCIETY OF CANADA.

TRANSACTIONS

SECTION IV.

GEOLOGICAL AND BIOLOGICAL SCIENCES.

PAPERS FOR 1886.

I.—*Presidential Address: Some Points in which American Geological Science is indebted to Canada.* *By* SIR J. WILLIAM DAWSON, C.M.G., LL.D., F.R.S.

(Read May 26, 1886.)

The position of Canada relatively to original work in Geological Science, is somewhat peculiar. Its territory embraces the whole series of geological formations, and is second to no other in the interest of its rocks and minerals, and the extent and excellence of its exposures. It is thus rich in the raw material of geological discovery. But its skilled and trained workers have heretofore been few. It is deficient in great libraries and in the apparatus of original research. It possesses no wealthy institutions able to render substantial aid, either to research or publication. Its Government has been unable to devote large sums to geological explorations, and such aid as it has given has been too much restricted to merely economic explorations.

With all this, it lies beside a much greater and more wealthy country, into which all its rock formations extend, and which excels it tenfold in number of workers, in means of publication, and in government aids to science. It would be too much to expect that this powerful neighbour and those who enjoy for the time its advantages, should always be generous, forbearing, or even just, or that they should fail to use to the utmost their superior vantage in the race for distinction. Practically, while Canada has had much reason to be grateful for the friendly and generous sympathy of the naturalists of the United States, it has had occasion, in some happily exceptional cases, to smart under their vigorous competition, and in some instances to deprecate a spirit of detraction or of unfair rivalry.

It is interesting in these circumstances to enquire what Canada has done in promoting the advance of Geological Science, and how far she has been able to keep pace with or anticipate discovery abroad. In directing your attention to a few facts bearing on this question, I shall not hesitate to include with our own native workers, those who have come to us from the mother countries of our population, just as in the United States it is customary to regard the great men who have been imported from abroad as Americans.

Perhaps the simplest way will be to begin with the older formations, and to notice Canadian discovery as it applies to the different successive periods of geological time, as represented in our country.

Canada has magnificent exposures of the oldest rocks. Our vast Laurentian and Huronian territory is unsurpassed in extent and importance. In this, therefore, we should have some claims to honourable distinction. That we have such is evidenced by the fact that the names "Laurentian" and "Huronian" are of world wide currency, and the discussions as to the origin and character of these old rocks, and their possible evidence of primitive forms of life, have centred around Canadian localities and specimens.

In this field, Canada has had some eminent workers. The ground was broken in 1823

by Dr. Bigsby's "Notes on the Geography and Geology of Lake Huron."[1] In this he sketched the primitive rocks of Canada, as extending from the north-east of Lake Winnipeg, passing thence along the northern shores of Lakes Superior, Huron and Simcoe, and after forming the granitic barrier of the Thousand Islands, spreading themselves largely throughout the State of New York. He also notices the principal varieties of gneiss and other old rocks, and recognizes their stratified character. About the same time, Richardson published his notes on the geology of Franklin's northern expedition.

This was followed up by important papers by Bayfield on the "Geology of the North Coast of the St. Lawrence"[2] and on Lake Superior,[3] and by papers on the Labrador coast and St. Paul's Bay by Lieut. Baddeley,[4] while Ingall described the country drained by the St. Maurice.[5] Baddeley's papers in particular, published in the early volumes of the Transactions of the Literary and Historical Society of Quebec, show much accurate knowledge of rocks and minerals and attention to stratigraphical relations, while in all these papers there is a clear discrimination between the old crystalline rocks and the overlying "transition" beds holding fossils.

It is not too much to say that these researches between the year 1820 and the institution of the Geological Survey of Canada in 1842, which have been well summed up by Dr. Harrington in his "Life of Sir William Logan," placed Canada for the time in a very advanced and honourable position.

But the work of Sir William Logan, beginning in 1842 and continuing until his death, marks an epoch not only in our knowledge of the Laurentian and Huronian in Canada, but throughout the world. Logan in his preliminary report notices that the labours of Bayfield, Bigsby, Baddeley, Wilson, Green and others, had before his time shown that the primary rocks, as he then termed them, "form a continuous line from one end to the other of Northern Canada." In his report for 1845, using Lyell's term "metamorphic," he defines the existence of a lower group of gneiss and of an overlying group containing crystalline limestones. He also at this time recognized the still higher formation subsequently called "Huronian," and a little later the distinctive characters of the Upper Laurentian were established. It was in 1854 that the name "Laurentian" was proposed in Logan's report for that year.

An attempt has recently been made by certain American writers, not, I am happy to say, men of much estimation in their own country, to belittle Logan's work, and even to throw doubts on the validity of the magnificent stratigraphical investigations by which he finally established the fact of the continuity and bedded character of the Laurentian system and the sequence of its deposits. These detractions might well be passed over in silence; but I may say here that, having gone over several of Logan's Laurentian sections with his maps and notes as my guides, I can testify to the minute accuracy of his work, and to the care and sagacity with which he had unravelled the relations of these difficult and disturbed formations. I have also much pleasure in knowing that the most eminent of the later writers on the Western Geology of the United States, like Chamberlin and Irving, fully accord with Logan's conclusions, which have long been accepted by the best authorities in Eastern America and Europe.

[1] Trans. Geol. Soc., Vol. i. Sec. ii. p. 175.
[2] *Ibid.* Vol. v. (1833) Sec. ii. p. 89.
[3] Trans. Lit. and Hist. Soc. of Quebec, Vol. i.
[4] *Ibid.* Vol. i.
[5] *Ibid.* Vol. ii.

Having been myself mixed up with the farther questions that have arisen as to the animal nature of Eozoon, and the vegetable origin of the abundant graphite of the Middle Laurentian, I shall say nothing of these farther than this, that if our Canadian conclusions should be substantiated, we shall stand here also in advance of the rest of the world.

In like manner I abstain here from entering into the question of the validity of the Montalban, Taconian and Keweenian of our colleague, Dr. Hunt, which are now subjects of earnest discussion, but I believe are in great part, at least, based on natural facts perceived by Logan in his original examinations of the Pre-Cambrian formations of the west, but more distinctly defined by Hunt, and which may eventually give a new triumph to Canadian geology. I may say here that my own observations have convinced me of the reality of the succession of (1) a Lower Laurentian series, the Trembling Mountain gneiss of Logan; (2) a Middle Laurentian, the Grenville series of Hunt; (3) an Upper Laurentian, the Labradorian or Norian series; (4) the Huronian series; (5) the Animikie series; (6) the Keweenian series. All these, except, perhaps, the last, are Pre-Cambrian, and belong to the Eozoic period. Of the Montalban I cannot speak so certainly. There is such a series, and this of great importance; but I do not know from my own observations its precise geological position.

I need scarcely say that the researches of Dr. Hunt in the chemical and dynamical geology of these ancient rocks and their relations to the origin of continents and mountain chains stand unsurpassed, and of themselves give to Canada a clear title to preeminence in this department.

Before leaving this subject, I may mention an attack which has been made on Sir W. Logan by an American writer, on the ground that the name "Laurentian" had been preoccupied by Desor. It seems that the latter had used the word "Lawrentian" to express the Pleistocene deposits of the St. Lawrence valley. But the name never gained any currency, and Logan's use of the term, "Laurentian," for the old crystalline series was only a little later,—Logan having applied the name in 1854, while Desor's use of the similar name "Lawrentian," had occurred in 1851. Logan and Hunt, who coöperated in the matter, based the name, not on the St. Lawrence River, but on the old name *Laurentides*, applied by Garneau to the mountain range composed of these rocks. In point of fact, the name "Laurentian" was based on the mountains composed of these rocks, and the name "Lawrentian" on the river itself; and the latter fell to the ground as useless and inappropriate.

The discovery of the rich Cambrian Fauna of St. John, New Brunswick, and in connection with this, that of the fossil plants of the neighboring Devonian beds, belong to the late Prof. C. F. Hartt, and to our colleagues, Mr. G. F. Matthew and Prof. Bailey. Of these discoveries I have remarked: "The collection and determination of the Cambrian fossils of what is now known as the Acadian group, and the excavation of the numerous Devonian plants of the same district, constitute in my judgment two of the most important advances ever made in the palæontology of Eastern America." Hartt published his first report on these fossils in 1865, and they were more fully described and illustrated in the second edition of my "Acadian Geology" in 1868. It is true that long before this time the *Paradoxides Harlani* of the Massachusetts shales had been discovered, and Emmons had endeavoured to illustrate the fossils of the Taconic system. But little attention had been given

to these facts, though as early as 1852 they had attracted the attention of the great Bohemian palæontologist, Barrande. Any one who studies the magnificent volumes of Hall, or the earlier editions of Dana's manual, will see that, until Hartt's discoveries were made, the view of American geologists scarcely extended lower in the Palæozoic than the Potsdam sandstone. The work so well begun by Hartt has been followed up by Matthew, and we have, in the last volume of our Transactions, a memoir in which many new forms are added to this ancient fauna, and we hope at our present meeting to have for the first time a subdivision of its fossils according to age, parallel to that ascertained in Western Europe. In a paper to be read at the present meeting, Mr. Matthew is able to tabulate sixty-five species and twenty-one varietal forms, from the lowest division of the Acadian group, corresponding to the earlier Cambrian of Europe.

A curious accident has recently happened in connection with Hartt's collections. These remained after his death in the United States, and were offered for sale, and should have been acquired for our Canadian collections. The fossil plants I purchased at my own expense for the McGill College collection, but the primordial fossils I had not means to redeem, and the Survey was at the time equally impecunious. They remained consequently in Cornell University, and Hartt's types, which Mr. Matthew should have had as the basis of his work, have been republished as a Bulletin of the United States Geological Survey, illustrated in a far more sumptuous manner than I was able to afford in my "Acadian Geology," and there can be little doubt that the effect will be that abroad an officer of that Survey will practically receive the credit which should belong to Canadians, though he has done little if anything to advance the knowledge of the subject beyond the point where Hartt left it. Prof. Bailey, who has been following up the stratigraphy of these rocks as ably as the fossils have been worked by Matthew, has directed my attention to the fact that in a recent, somewhat pretentious volume issued in Cambridge, the work of Canadian geologists in these rocks is sneered at, and that by unfair citations of statements made at different times and during the progress of discovery, we are made to appear as at variance with one another. On this subject I would say that, in my own connection with the geology of the Maritime Provinces, I have ever endeavoured to promote the work of my younger geological friends; have at once admitted any new discovery, even when contradicting the conclusions I had formed from a less complete induction of facts; and that the work of Hartt, Matthew and Bailey in the complicated and disturbed coast rocks of southern New Brunswick has produced results in stratigraphy and palæontology more accurate, complete and important in the interests of science, than any that can be shown with reference to the continuation of these same rocks in New England.

If the holding of different opinions on debatable points, and the free and active discussion of these opinions is to be a ground of accusation against Canadian geologists, I fear the next great group of rocks, that Siluro-Cambrian series to which Logan gave the name "Quebec Group," may afford more ground of complaint. It would be useless here to attempt to summarize the discussions in which Hall, Emmons, Dana, and many other American geologists have taken part, or the bold and masterly way in which Logan and Billings cut the Gordian knot, or the subsequent discussions of Hunt, Selwyn and Macfarlane. I have elsewhere noticed these subjects, and hope to do so again before long. I may content myself with quoting a general statement on the subject, made in 1879, and still I think correct.

When Sir William Logan commenced the Geological Survey of Canada in 1842, the older rocks, in so far as his field was concerned, were almost a *terra incognita*, and very scanty means existed for unravelling their complexities. The "Silurian System" of Murchison had been completed in 1838, and in the same year Sedgwick had published his classification of the Cambrian rocks. The earlier final reports of the New York Survey were being issued about the time when Logan commenced his work. The great works of Hall on the palæontology of New York had not appeared, and scarcely anything was known as to the comparative palæontology and geology of Europe and America. Those who can look back on the crude and chaotic condition of our knowledge at that time, can alone appreciate the magnitude and difficulty of the task that lay before Sir William Logan. To make the matter worse, the most discordant views as to the relative ages of some of the formations in New York and New England which are continuous with those of Eastern Canada, had been maintained by the officers of the New York Survey.

Sir William made early acquaintance with some of these difficult formations. His first summer was spent on the coast of Gaspé and the Baie des Chaleurs, where he saw four great formations, the Quebec group, the Upper Silurian, the Devonian, and the Lower Carboniferous, succeeding each other, obviously in ascending order, and each characterized by some fossils, most of which, however, were at that time of very uncertain age. I remember his showing me in the autumn of that year the note-books in which he had carefully sketched the stratigraphical arrangements he had observed, and also the forms of characteristic fossils. But both wanted an interpreter. The plants of the Gaspé Devonian were undescribed; many of them of forms till then unheard of. The shells and corals and graptolites of the older formations could be only roughly correlated with some of those in the New York reports. The rock formations are very unlike those of the New York series. Still this work of 1842 and 1843 was plain and easy, compared with that which arose in tracing these formations to the south-west. I may add here that I have since studied some of these Gaspé sections with Sir William's manuscript note-books in my hand, and have been amazed at the extraordinary care and exactitude with which every feature of the rocks had been observed and noted down. Much of the detail in these early note-books of Sir William still remains unpublished. Those who would detract from the work of Sir Wiilliam Logan, if there are any such, should remember these early beginnings, and compare them with the massive foundations which have been laid for us to build upon.

And now, after the labour of more than thirty years on the part of Sir William and those he had gathered around him, how do these subjects stand? (1) We have all the comparatively flat and undisturbed formations of the great plains of Upper and Lower Canada, our share of the interior continental plateau of America, worked out and mapped, and their fossils characterized so that a child may read them. (2) The complex hilly districts, with their contorted, disturbed and altered beds, which extend from New England to Gaspé, have been traversed in every direction, the limits of their different formations marked, and a theory as to their age and structure put forth, which, whether we accept it or not, has in it important features of the truth, and rests on facts on which every disputant must take his stand. (3) We have the still older formations of the Laurentian hills traced in their sinuous windings, and arranged in an order of succession which must stand whether the names given by Sir William, and now accepted throughout the world, be objected to or not. After the work of Sir William Logan, no cavilling as to names can ever

deprive Canada of the glory of being the home of the scientific exploration of the Laurentian; and much examination of the ground which he explored enables me to affirm that no one will ever be able permanently to overset the general leading subdivisions which he established in the Laurentian and Huronian systems.

We may sum this matter up, in so far as Sir William Logan's work is concerned, and that of his assistants, and of Hall and Billings in the department of palæontology. Their researches have established:—(1) The general diversity of mineral character in the Palæozoic sediments on the Atlantic slope as compared with the internal plateau of Canada. In these results Bailey, Matthew and Hartt in New Brunswick, and the writer in Nova Scotia, have also borne some part. (2) The establishment of the Quebec group of rocks as a series equivalent in age to the Calciferous of America, and to the Arenig and Skiddaw of England, and the elucidation of its peculiar fauna. (3) The tracing out and definition of the peculiar faulted junction of the coastal series with that of the interior plateau, extending from Quebec to Lake Champlain. (4) The definition in connection with the rocks of the Quebec group, by fossils and stratigraphy, of formations extending in age from the Potsdam sandstone to the Upper Silurian, as in contact with this group, in various relations, along its range from the United States frontier to Gaspé; but the complexities in connection with these various points of contact, and the doubts attending the ages of the several formations, have never yet been fully solved in their details. (5) The identification of the members of the Quebec group and associated formations with their geological equivalents in districts where these had assumed different mineral conditions, either from the association of contemporaneous igneous beds and masses, or from subsequent alteration, or both. It is with reference to the results under this head, the most difficult of all, that the greater part of the objections to Sir William's views have arisen, and that recent discussions and observations have somewhat modified his conclusions.

I may be permitted to add that we hope to have at this meeting a communication from Prof. Lapworth, so well known as an authority on Graptolites, in which he compares the fossils of this group found in Canada with those of Europe, and while giving important new light on the whole subject, substantiates the conclusions previously arrived at by Canadian geologists, and published in local reports and periodicals.

In the wide-spread Siluro-Cambrian, Silurian and Devonian formations of the great interior plateau of the American continent, the geologists of the State of New York have had the start of us, and Hall stands *facile princeps* as their interpreter. Hall has, indeed, by his services to Canadian palæontology, as well as to that of the United States, entitled himself to adoption as a Canadian, and has been so adopted by various societies and institutions, but next to him we have a right to place Billings, whose accurate work and sagacious insight are unsurpassed, and whose industry is evidenced, as I am informed by his successor, by his descriptions of more than one thousand new species and sixty-nine new genera, while he has added not merely to our catalogue of Canadian fossils but to the knowledge of the world. Another special claim of Canada is that to the ownership of the Guelph formation, a fossiliferous group wanting in the State of New York, and thus filling a gap in the history of life in the Silurian age in America. The fossils of this formation were studied by Mr. Billings, and still more recently the collections of Mr. Townsend, a local collector, have been described by Mr. Whiteaves, and have added several new fauna to those previously known.

Of those upper members of the Palæozoic series with which I am myself most conversant, I shall not say much. Canada has taken the lead in the discovery of insects of the Devonian or Erian period. We have discovered and described more of the land plants of that period than are known in any other country, perhaps in all other countries; and the Devonian flora of Canada is the term of reference and comparison for that of all other countries. New interest has been added to the Erian of America by the discovery, first made known by Mr. Ells, of fossil fishes in rocks of this age at the mouth of the Restigouche River, a discovery followed up by Mr. Foord, and by the description of the specimens by Mr. Whiteaves. The results are a Lower Devonian fish fauna characterized by Cephalaspis and Coccosteus and two species of selachians, and an Upper Devonian fauna affording Pterichthys, Phaneropleuron, etc., in all eight species. It is interesting to note that these faunas are associated with plants characteristic respectively of the Lower and Upper Devonian.

Much has been done in the Carboniferous flora, and more especially in the discrimination of its successive stages, from the Lower Carboniferous to the Permian. To us science owes the earliest discovery in America of Carboniferous batrachians, the oldest stomapod crustacean, and the first known palæozoic land shells and millipedes; and some of our grand coast sections and exposures of Carboniferous rocks have become as familiar as household words to the geologists of every country.

Canada is not richly endowed with rocks of the early Mesozoic age, except perhaps in those western districts as yet only imperfectly explored. Our Triassic rocks and their associated trappean beds were very early studied, and though here we owe much to Jackson and Alger, we have also done much for ourselves. I was amused not long ago to see relations of the trappean rocks to the red sandstones long ago established in Nova Scotia, only beginning to be applied to the similar rocks of Connecticut and New Jersey.

Our Cretaceous and Tertiary rocks of the Northwest are only as yet partially explored. Still we have already done something to elucidate their structure. The work of Dr. Selwyn, Mr. Richardson, Dr. G. M. Dawson and Mr. Whiteaves, has thrown much new light on their age and distribution, and we have, I think, taken the lead in disentangling the confusion introduced into their flora by a too rigid adhesion to arbitrary classifications introduced into palæobotany in Europe. We can show in the Transactions of this Society the first clear and consecutive sequence of plants from the Lower Cretaceous into the Eocene, and the conclusions based many years ago on collections made in Canadian territory, are only now being introduced to notice and recognized as correct in the United States.

In this connection an important discovery has been made by Mr. Whiteaves in the study of the fossils collected by Mr. Richardson and Dr. G. M. Dawson, in the Queen Charlotte Islands. Mr. Whiteaves, whose previous studies in English Mesozoic fossils entitle him to be regarded as an authority in this matter, finds evidence that beds of the age of the English Gault exist in these western regions, and that a portion of the so-called Jurassic of the western territories of the United States, is probably Lower Cretaceous. This fact brings the geology of the West more into harmony with that of the eastern part of America, which seems to have been dry land during the Jurassic period. I find, however, that, in a recent article in the "American Journal of Science," Mr. Whiteaves complains, apparently with justice, that while his conclusions have been only partially accepted, credit is denied

for the corrections introduced by him, and even the collections and stratigraphical observations on which his results were based, are disparaged.

The quiet way in which the American palæontologist speaks of the collections made by Richardson and Dr. Dawson as "some fossils," "reported to come from certain beds," when these extensive collections are known to be accompanied with the most careful stratigraphical work, would be amusing if it were not provoking. It is only to be paralleled by the similar simplicity of some European palæontologists. One of these, in discussing the nature of Eozoon laments that no accurate geological work has been done on the Canadian Laurentian. Another, when affirming the Cretaceous plants of Vancouver Island to be Miocene, speaks of the geology of this island as quite unknown, and a third coolly assumes the Devonian beds of New Brunswick to be Carboniferous, because he supposes that no one has explored the stratigraphy of these unknown regions!

In the disputed questions of Pleistocene geology it would be premature to make any boast. I may say, however, that the Canadian school of geologists has distinguished itself by moderate views as to the Glacial period. The fact that we can study on our own coasts many of its operations still in progress has contributed to this. We have also the advantage in the St. Lawrence valley and the western plains of a vast horizontal distribution of Pleistocene beds, and of very rich fossiliferous deposits. Certain it is that we have taken the lead in working out the fauna and flora of the so-called "Glacial Period," and have so far avoided those more extreme notions of continental glaciation which have gained currency in the United States. I feel convinced that ultimately our caution in this will be vindicated, and that we shall find that the sober afterthought of geologists will refer the glaciation of rocks and the transport of boulders quite as much to the action of marine currents and floating ice as to land glaciers. A powerful reaction is taking place in this direction in Europe, and though the influence of certain great names still upholds in the United States very extreme views as to the Glacial Age, they must soon be toned down within the limits demanded by our knowledge of physical facts and possibilities.

I have been able to refer only very generally to a few of the leading departments of geological discovery in which this country has taken the lead or has successfully followed. Enough has been said to show that though Canadian science labours under many disadvantages, its votaries have not thereby been deterred from working, and that their labour has not only been crowned with a fair measure of success, but that they have in many cases been able to act as teachers to those who might be supposed to have advanced far beyond them. It remains to our younger men to uphold and extend our good reputation in these respects, and I trust that as many of them have been favoured with educational advantages beyond those of their predecessors, they may also be supplied with greater facilities for exploration and publication, and that our public men will beware of falling into the popular mistake of limiting our scientific expenditure by a narrow and slavish utilitarianism which defeats its own ends.

II.—*Recent Additions to Canadian Filicineæ, with New Stations for some of the Species previously recorded.* *By* T. J. W. BURGESS, M.B.

(Presented May 28, 1886.)

The discovery, since the publication of a revision of Canadian Filicineæ by Professor Macoun and myself in the Transactions of this Society for 1884, of several ferns, not hitherto regarded as Canadian, and additions to the stations recorded for some of the rarer species therein mentioned, leads me to hope that a brief supplemental paper on the same subject will not be quite wanting in interest, and to facilitate reference, the numbering of the genera, etc., in the previous article, has been retained through this.

ORDER.—**OPHIOGLOSSACEÆ**, *Lindl.*

Genus I.—OPHIOGLOSSUM, *L.*

1.—O. VULGATUM, *L.* The unknown Nova Scotia station of Professor McCulloch (*vide* "Canadian Filicineæ" in Trans. Roy. Soc. Can., Vol. II, Sect. IV, p. 174), has probably been rediscovered; Mr. Campbell, a student of Dalhousie College, having in 1884 found it in a field near Truro, at which place Mr. McCulloch used to live. Low meadow, Port Stanley, Elgin Co., Ont.—*J. Bowman.*

Genus II.—BOTRYCHIUM, *Swz.*

1.—B. LUNARIA, *Swz.* Open spaces in damp, grassy thickets at the Hudson's Bay Co.'s post on Lake Mistassini, and in a similar locality near the Oatmeal Falls on Rupert River, Northeast Territory.—*J. M. Macoun.*

2.—B. MATRICARIÆFOLIUM, *A. Br.* On damp hillsides, under bushes, Dalhousie, N. B.—*J. Fletcher.* Regina, Assa.—*N. H. Cowdry.* Some specimens collected by Professor Macoun in 1885, near Silver City, Alta., on the grassy slope below the peak of Castle Mountain, Rocky Mountains, are perhaps referable here, but are too immature to admit of separation with certainty from *B. lunaria.* Further search in this locality for more mature specimens is of importance, since, if true *B. matricariæfolium*, our western limit for this species ceases to be Regina.

3.—B. LANCEOLATUM, *Angs.* In the Rev. Jas. Fowler's revised list of New Brunswick plants (Bull. Nat. Hist. Soc. N. B., No. IV.) a new station, Kennebeccasis, is recorded by Mr. G. U. Hay, but I have seen none of the specimens.

5.—B. TERNATUM, *Swz.* Old pastures, Truemanville, Cumberland Co., N. S.—*H. Trueman.* One of the specimens received from this locality has two perfect sterile fronds,

the one rising from near the base of the plant, the other about an inch and a half higher up. While examples with two sterile fronds, one the product of the previous year, are common, in this case the two are the growth of the same season. In addition, these fronds are much more membranaceous than usual, lacking, indeed, almost completely, that fleshiness so characteristic of this species. Growing with *B. lunaria*, but rare, at the Oatmeal Falls, Rupert River, N. E. Terr. (var. *rutæfolium*).—*J. M. Macoun.* Very rare on the snow slides near the summit of the Selkirk Mountains, B. Col., on the line of the C. P. Ry.—*Macoun.* Common about Victoria, Vancouver Island, B. Col., amongst bushes on the margins of lakes and swamps (var. *australe*).—*J. R. Anderson.*

Var. DISSECTUM, *Milde.* Very characteristic specimens were collected in 1885, by Professor Macoun, in woods near the Whirlpool, Niagara Falls, Ont., where also was found an approach to var. *obliquum*, Milde.

6.—B. VIRGINIANUM, *Swz.* Under hardwood trees, Truemanville, Cumberland Co., N. S.—*H. Trueman.* Very abundant in open, boggy woods, and in burnt woods of any kind, all around Lake Mistassini, N. E. Terr.—*J. M. Macoun.* Rather rare on grassy slopes, and in open woods, from Laggan in the Rocky Mountains, Alta., to Donald in the Columbia Valley, B. Col., along the line of the C. P. Ry.—*Macoun.* Common in rich woods about Victoria, and in other parts of Vancouver Island, B. Col.—*J. R. Anderson.* The so-called var. *gracile*, Hook. and Grev., is noted in the Rev. Jas. Fowler's revised list as occurring on dry, rocky heights at the mouth of the Upsalquitch River, N. B.

ORDER.—**FILICES,** *Juss.*

Genus I.—POLYPODIUM, *L.*

1.—P. VULGARE, *L., var.* CAMBRICUM, *Willdenow;* (*P. Cambricum*, L.) Specimens referable to this form, commonly known in England as Welsh Polypody, from its being originally collected in Wales, have been found within our limits. They were obtained on rocks at Port Simpson on Portland Inlet, B. Col., opposite the southern extremity of Alaska, and were furnished by Mr. J. R. Anderson of Victoria, B. Col. The fronds are broader and more oval in general outline than in the type, while the primary divisions are acute, widened in the middle, and pinnatifid into narrow, variously shaped segments, many of which are serrulate. Being fertile, the specimens might be placed under var. *semilacerum*, Moore, sometimes called Irish Polypody, from its having been first noticed in Ireland, but Dr. Milde includes this form under var. *Cambricum*, the original type of which is always barren, and I have preferred to follow him.

Genus II.—GYMNOGRAMME, *Desv.*

1.—G. TRIANGULARIS, *Kaulf.* Reported by Mr. J. R. Anderson as common about Victoria, B. Col., on bare hills under the shady sides of rocks.

Genus III.—CHEILANTHES, *Swz.*

1.—C. GRACILLIMA, *D. C. Eaton.* Of this species, Mr. Anderson writes to me, "found

in fissures of dry rocks on Mount Finlayson, at the head of, and on other hills on the east side of, Saanich Arm, near Victoria, B. Col."

Genus IV.—PELLÆA, *Link.*

1.—P. GRACILIS, *Hook.* Madawaska, N. B.—*Hay* (Fowler in Bull. Nat. Hist. Soc. N. B., No. IV.) Crevices of wet rocks at the mouth of Temiscami River, about twenty-five miles from the east end of Lake Mistassini, N.E. Terr.—*J. M. Macoun.* Crevices of rocks in rear of the C. P. Ry. water-tank at Kicking Horse Lake, and at Mount Stephen, B. Col.—*Macoun.* Rocky hillsides, not common, Kootenay District, B. Col.—*J. R. Anderson.*

2.—P. ATROPURPUREA, *Link.* Very rare in crevices of limestone rocks on the mountains near Kananaskis Station on the C. P. Ry., Alta.—*Macoun.* Hillsides amongst broken rocks, not common, Kootenay District, B. Col.—*J. R. Anderson.*

Genus V.—CRYPTOGRAMME, *R. Br.*

1.—C. ACROSTICHOIDES, *R. Br.* Common at Victoria, B. Col., among rocks on bare hills.—*J. R. Anderson.*

Genus VI.—PTERIS, *L.*

1.—P. AQUILINA, *L.* Common at Lake Mistassini, and down the Rupert River to James Bay, N. E. Terr.—*J. M. Macoun.*

Var. LANUGINOSA, *Bong.* Our eastern range for this form is now known to extend at least as far as the Columbia River, B. Col., Professor Macoun having found it, in 1885, abundant in pine woods in the valley of that stream, along the line of the C. P. Ry.

Genus VII.—ADIANTUM, *L.*

1.—A. PEDATUM, *L.* "Keswick Ridge, York Co.,—*Fowler;* Andover, Victoria Co.,—*Hay;* Moose Mountain, Carleton Co.,—*Dr. Bailey.*" (Fowler, in Bull. Nat. Hist. Soc. N. B., No. IV.)

Var. RANGIFERINUM, *n. var.* Pinnules longer stalked, convex on the lower border, rising from the rachis at an acute angle, gradually tapering at the base, deeply cleft into narrow, toothed lobes on the upper side, rounded from below upward at the outer extremity; sori few.

This very peculiar and beautiful form, to which the name *rangiferinum* has been given on account of the resemblance of the pinnules to the horns of the reindeer, was found on thickly shaded rocks overhanging the waters of Gold Stream, at the base of Mount Finlayson, twelve miles from Victoria, B. Col., by Mr. J. R. Anderson. The pinnæ are very few in number and long in proportion to the size of the plant, e. g., a specimen about two feet high has only three on each of the primary branches, those nearest the forking on each side measuring not less than thirteen inches. It is in the pinnules, however, that the most marked peculiarities are seen. These, in the ordinary form, are short stalked, spring from the rachis at right angles, and have the lower margin usually straight or more or less concave, but in this they are well petioled, rise at a very acute angle, and

have the lower border markedly convex. Their base, instead of being straight and square, is gradually tapering; the upper edge is deeply cleft into narrow, toothed lobes; and the outer extremity is not rounded from above downward, but has its upper margin projecting beyond the lower, so as to make the rounding just the reverse. Only a few of the lobes are fertile. The accompanying figure of a part of a pinna will probably give a better idea of these distinctions.

FIG.—A. pedatum *var.* rangiferinum.

Interesting points about this plant, which I am now trying to determine, refer to the frequency of its occurrence and constancy in cultivation.

Genus VIII.—LOMARIA, *Willd.*

1.—L. SPICANT, *Desv.* Reported by Mr. Anderson as common in rich woods near Victoria, Vancouver Island, B. Col., and along the coast of the mainland. All the specimens that I have seen from this locality have the pinnæ, except the lower reduced ones, acute or mucronate instead of obtuse, as is said to be oftenest the case.

Genus X.—ASPLENIUM, *L.*

1.—A. VIRIDE, *Huds.* Clefts of shaded rocks at the mouth of Temiscami River, twenty-five miles from the east end of Lake Mistassini, N. E. Terr.—*J. M. Macoun.* In rich soil amongst broken rocks, at Port Simpson on Portland Inlet, Northern B. Col.—*J. R. Anderson.*

2.—A. TRICHOMANES, *L.* Amongst broken rocks on Mount Isonhailim, near the mouth of Cowichan River, Cowichan District, Vancouver Island, and in Kootenay District, B. Col.—*J. R. Anderson.*

5.—A. THELYPTEROIDES, *Mx.* For New Brunswick, where this fern is said to be scarce, the following new stations are recorded: "Bass River,—*Fowler*; Fredericton,—*Vroom*; Salmon River, Victoria. Co.,—*Hay.*" (Fowler, in Bull. Nat. Hist. Soc. N. B., No. IV.)

Genus XI.—SCOLOPENDRIUM, *Smith.*

1.—S. VULGARE, *Smith.* Three interesting forms, vars. *marginatum*, *ramosum* and *multifidum*, of this very variable fern, collected near Woodstock, N. B., have been received from Mr. Peter Jack of Halifax, N. S.

Var. MARGINATUM, *Moore.* (Nature Printed British Ferns, II, pp. 139 and 166; Handbook of British Ferns, 3rd ed., 198). The following is Mr. Moore's description:—"Fronds

narrow-oblong, strap-shaped, truncate at the base; attenuate at the apex, the margin inciso-lobate; fertile; the epidermis of the under surface also developed near the margin into a lobed, excurrent membrane, which bears sori on both surfaces." In the New Brunswick specimens, the peculiar lobed, excurrent membrane is well marked, and gives the frond the appearance of being double, i. e., as if two fronds, both soriferous, had been pasted together, the one on top of the other. The layer corresponding to the frond proper slightly exceeds (one-sixteenth to one-eighth of an inch) that from the epidermis, and is lobed and dentate. The only deviation, which is of little account, from the description, is that the base is heart-shaped and auricled instead of truncate. *S. vulgare* is occasionally seen with sori on the upper as well as the under surface of the fronds, which abnormality sometimes proceeds from the normal sori being prolonged round the margin; but at others they are produced on the upper side within the margin, and without corresponding ones beneath. This freak, caused in the first of these ways, is a marked feature in some of the Woodstock specimens of var. *marginatum*, which have thus four soriferous surfaces instead of the usual three.

Var. RAMOSUM, *Gray.* (Moore's Nature Printed British Ferns, II, pp. 140 and 195; Handbook of British Ferns, 3rd ed., 199.—*S. officinarum*, Swz., var. *ramosum*, Willd.) Mr. Jack's specimens closely approach this variety, which is said to be constant in cultivation and reproduce itself from spores, being characterized by their short fronds having the stipes branched, the branches, which start singly from the stipes, becoming ramified like the branches of a tree, and ending in crisped tufts.

Var. MULTIFIDUM, *Gray.* (Moore's Nature Printed British Ferns, II, pp. 140 and 188; Handbook of British Ferns, 3rd ed., 198.—*S. officinarum*, Swz., var. *multifidum*, Schk.) In this form the stipes are unbranched, but the fronds are furcately divided at the apex, and these divisions are few—to many—cleft at their points.

Genus XIII.—PHEGOPTERIS, *Fee.*

1.—P. POLYPODIOIDES, *Fee.* Rather rare near the line of the C. P. Ry. in the valley of Beaver Creek, Selkirk Mountains, B. Col., both along this stream on stumps, and on rocks along mountain torrents near Stony Creek.—*Macoun.* Shaded, rocky places, Port Simpson on Portland Inlet, Northern B. Col.—*J. R. Anderson.*

2.—P. HEXAGONOPTERA, *Fee.* In rich woods, not common, just east of the Waterworks Reservoir, Toronto, Ont.—*Burgess.*

4.—P. CALCAREA, *Fee.* Not rare in rather low woods at the base of limestone cliffs, and in crevices of the cliffs themselves, at the mouth of Temiscami River, Lake Mistassini, N. E. Terr.—*J. M. Macoun.*

5.—P. ALPESTRIS, *Mett.* The finding of this species in British Columbia, by Professor Macoun, in August, 1885, is strongly confirmatory of its having been originally collected by Dr. Lyall in the Cascade Mountains of the same province. It grew abundantly, at an altitude of 7000 feet, in wet places on the slopes of the glacier mountain along Bear Creek at the summit of the Selkirk Mountains, near the line of the C. P. Ry. The stalks of most of these specimens are long in proportion to the size of the plants, in the largest making

eight inches of the total twenty-four. The fronds, rather narrowly oblong-lanceolate in general outline, are gracefully acuminate, and have all the pinnæ densely soriferous, the lower ones being distant and considerably decreased in size.

Genus XIV.—ASPIDIUM, *Swz.*

2*a*.—A. OREOPTERIS, *Swz.*, (Mountain Shield-Fern), Syn. Fil., 50. Willdenow, Sp. Pl., V, 247. Eaton, Ferns of N. A., II, 273. Underwood, Our Nat. Ferns, etc., 105.

A. montanum, Milde, Fil. Eur. et Atlant., 115.

A. odoriferum, Gray.

Polypodium fragrans, L.

Polypodium montanum, Vogler.

Polypodium pterioides, Villars.

Polypodium limbospermum, Bellardi.

Polypodium oreopteris, Ehrh.

Polypodium thelypteris, Bolton.

Polystichum montanum, Roth.

Lastrea oreopteris, Presl.

Lastrea montana, Moore.

Hemestheum montanum, Newman.

Nephrodium oreopteris, Desvaux.

Nephrodium montanum, Baker.

This is a rich, golden-green, handsome, though rather stiff-looking species, found growing in patches, usually in open wet ground, in ravines and on mountain slopes, and varying in height from one to three feet. Rootstock short, stout, erect or ascending, chaffy, and covered with old stalk-bases; stalks short, generally forming about one-fifth or less of the height of the plant, somewhat chaffy especially at the base; fronds erect, firmly membranaceous, glandular beneath, commonly with some scattered chaff along the rachis, ten to thirty inches long, lanceolate in outline, acute, tapering from near the middle to a narrow base, pinnate; pinnæ sessile from a broad base and deeply pinnatifid, the middle ones lanceolate-acuminate and two to five inches long, gradually reduced to the lowest, which are deltoid, one-third to one inch long and slightly but increasingly distant; pinnules numerous, oblong, obtuse, entire or slightly crenulate, and, like *A. thelypteris*, their margins sometimes revolute so as to give them the appearance of being acute; veins free, often forked; sori near the margin; indusia very delicate, more or less toothed at the margin, fugacious.

This fern approaches more closely to *A. thelypteris* than to any other of our Canadian species, but is readily separated, both from it and from *A. Noveboracense*, by its tufted, not creeping, rootstocks. In the absence of root, the most obvious distinguishing characteristics are that, in the former, the stalks are long, the fronds are rarely narrowed at the base, the veins are nearly all forked, and the sori are not marginal; while in the latter, the fronds are thin-membranaceous, minutely ciliate and hairy, and the veins are almost always simple. Of North American species as a whole, however, *A. oreopteris* finds its closest ally in the Californian *A. Nevadense*, Eaton. The rootstocks are alike, and both are narrowed to the base, but as a rule, the former is a coarse, rigid fern, and the latter is slen-

der and graceful, with thinly membranaceous fronds, which have the pinnæ cut deeper with wider sinuses and narrower lobes, and the veins mostly simple.

The fronds of all the Canadian plants I have seen are narrower and more graceful looking, both as a whole and in all their parts, than those of Unalaskan and most European and Asiatic forms, but Professor Eaton, to whom a specimen was sent, writes me, "most fronds are broader and have broader pinnules, but I have one from Mettenius which is as narrow and slender as yours." The largest of our specimens examined is one foot and one-half long, of which three and one-half inches form the stalk, while the middle pinnæ are only about two inches long. The segments, the basal ones of which, especially on the upper side, are often large in proportion to those next them (often twice as long) are but little more than a line in width, and the under surface is but very slightly glandular.

A. oreopteris is common in Europe, from England to Spain and to Russia, occurring also in Madeira and Asia Minor, but is not found in Siberia. In America, previous to 1885, it was only known to exist on the Island of Unalaska, where Mr. L. M. Turner found it in 1878, but in August of that year it was discovered by Professor Macoun on Mount Dawson, at the summit of the C. P. Ry. pass through the Selkirk Range, B. Col., a little south of lat. 51°. It grew in large patches, at an altitude of 6500 feet or a little less, on a comparatively dry slope about 1500 feet from the summit of the mountain, immediately below the bare, sloping rock, and also in wetter soil and at a greater altitude on a neighboring mountain, the upper slopes of which were covered by a glacier.

NOTE.—As this fern belongs to the subgenus *Nephrodium* and finds its closest relative, among our species, in *A. thelypteris*, its discovery, owing to its less thinly membranaceous character and want of creeping rootstocks, would necessitate a change in, and subdivision of, subsection * of that subgenus in "Canadian Filicineæ," (Trans. Roy. Soc. Can., Vol. II, p. 200). The first part of *Aspidium*, in the article referred to, should therefore, by the introduction of this species, read:—

§ Indusia kidney-shaped or round, with a narrow sinus.

* Fronds membranaceous, decaying in autumn, bipinnatifid. Veins simple or once forked.

† Rootstock slender and creeping, with scattered fronds.

A. Noveboracense, Swz.

A. thelypteris, Swz.

†† Rootstock short, with clustered fronds.

A. oreopteris, Swz.

3.—A. CRISTATUM, *Swz.* So far as known, this fern is scarce in New Brunswick, and the following stations only are recorded: "Bass River, Green Head,—*Fowler, Hay;* Andover and Upper Gaspereaux,—*Wetmore.*" (Fowler, in Bull. Nat. Hist. Soc. N. B., No. IV.)

5.—A. FILIX-MAS, *Swz.* A second New Brunswick station has been discovered, viz., Daley's Wood, Richmond.—*Hay.* (Fowler, in Bull. Nat. Hist. Soc. N. B., No. IV.) Abundant on the line of the C. P. Ry. on the lower slopes of Mount Carroll near Bear Creek, summit of the Selkirk Range, B. Col.—*Macoun.*

11.—A. LONCHITIS, *Swz.* One of Mr. A. H. MacKay's Aspey Bay, Cape Breton, speci-

mens presents, in its upper two-thirds, a marked resemblance to *A. munitum*, having narrow and wide-spreading, nearly sessile pinnæ, which are almost destitute of falcateness. Their teeth, too, are incurved and almost free from the bristle points, which give so formidable an appearance to typical *A. lonchitis*. All this gentleman's other specimens that I have seen, from the same locality, are in every respect normal, except that the stalks of some of them are longer than is usual in this species. On the upper slopes of Cathedral Mountain at Kicking Horse Lake, B. Col., and on the snowslides near the summit of the Selkirk Mountains, B. Col.—*Macoun.*

12.—A. ACROSTICHOIDES, *Swz.* A peculiar form of this was found by Mr. Peter Jack near Halifax, N. S. The whole of the fronds had the edges of the pinnæ crinkled or crimped, while their points were rounded. In other respects, the specimen sent me, which was barren, resembled the type. Some additional New Brunswick stations are "Upper Tobique and Kennebeccasis,—*Hay;* Mosquito Cove,—*Mrs. Heustis;* Andover, common at Salmon River,—*Wetmore.*" (Fowler, in Bull. Nat. Hist. Soc. N. B., No. IV.)

14.—A. ACULEATUM, *Swz.*, (Prickly Shield-Fern, Hard Prickly Shield Fern), Syn. Fil., 53. Willdenow, Sp. Pl., V. 258. Hooker, Sp. Fil., IV. 18. Milde, Fil. Eur. et Atlant. 104. Hook. and Baker, Syn. Fil., 252. Eaton, Ferns of N. A., II. 123. Underwood, Our, Nat. Ferns, etc., 103.

A. aculeatum, α *lobatum*, Hook.

A aculeatum, var. *lobatum*, Kunze ; Eaton, Ferns of N. A., II, 124.

A. lobatum, Smith ; Swartz, Syn. Fil., 53.

A. lobatum, α *vulgare*, Doell.

Polystichum Plunkeneti, DC.

Polystichum aculeatum, Presl.

Polystichum aculeatum, var. *lobatum*, Moore.

Polypodium aculeatum, Fries.

Polypodium lobatum, Huds.

A handsome, evergreen, prickly-looking fern, found growing among rocks or in rocky ravines, generally in mountainous districts. It attains a height of one to three feet, the fronds forming a crown. Rootstock stout, erect or ascending, covered with old stalk-bases ; stalks variable in length but considerably shorter than the fronds, very chaffy with large and small brown scales intermixed, as is the rachis and usually its branches ; fronds one to two feet long, dark-green, rigid, subcoriaceous, more or less chaffy-fibrilose beneath, lanceolate or oblong-lanceolate, tapering to the apex and also toward the base, pinnate ; pinnæ lanceolate from a broad base, acute, generally curved upward (some of the lower sometimes horizontal or deflexed) incisely pinnatifid or again pinnate ; pinnules obliquely set, variable in shape, rhomboid-oval and sessile or unequally triangular-ovate and auricled on the upper side of a slightly stalked base, the superior basal ones generally much larger than the next and more distinctly auricled, serrate with the teeth aculeate in varying degrees ; sori in two rows on the segments, nearer the midvein than the margin.

Professor Eaton states that the difference between typical *A. aculeatum* and var. *lobatum* is only that usually seen between the fronds of mature (therefore more divided) and younger plants, and includes in var. *lobatum*, like Kunze and Milde, both these forms. I have

preferred, however, to combine the two under the specific name, and have also included the synonymy of both under the same head.

The Californian forms, var. *Californicum*, Eaton, and var. *angulare*, Braun, are, broadly speaking, distinguished from the type by the pinnæ of the former being less, of the latter more divided. In var. *Californicum*, which is more like a hybrid between *A. munitum* and *A. aculeatum* than anything else, the fronds are much elongated, scarcely narrowed at the base, and so little divided that even the superior basal segment is scarcely distinct as a pinnule and is not at all auricled. In var. *angulare* the fronds, which are lighter colored and less stiff, rigid and prickly-looking, are scarcely or not at all narrowed at the base, and so much divided as to be truly bipinnate, the pinnules being distinctly short-stalked, mostly auricled, slightly incised, and the superior basal one often again pinnatifid. Var. *Braunii*, Doell, differs in being less rigid and much thinner in texture, with shorter stalk, more narrowed base, and more divided pinnæ, the lower of which are obtuse; the pinnules, too, which are more distinct and auricled, have short stalks and truncate, rectangular bases, while the under or both sides of the fronds are covered with characteristic, long, soft hairs, which are absent or very scanty in true *aculeatum*. Var. *scopulinum*, D. C. Eaton, is readily recognized by its short, narrowly lanceolate, almost smooth fronds, which have ovate, rather obtuse pinnæ, with less aculeate teeth.

Of a Canadian example sent him, Professor Eaton remarks :—"I have not before this seen anything just like your specimen. It is more exactly the European var. *lobatum* than any I have had from California, the difference being in the firmer texture of your plant, and the decidedly more aculeate teeth of the pinnules."

Heretofore the only forms of *A. aculeatum* known to be Canadian were vars. *Braunii* and *scopulinum*, the specimens now referred to the type having been received in 1886 from Mr. J. R. Anderson of Victoria, B. Col., who informs me they were collected in moist, rocky places at Port Simpson, on Portland Inlet, Northern B. Col.

Genus XV.—CYSTOPTERIS, *Bernh.*

2.—C. BULBIFERA, *Bernh.* "Very abundant about Lower St. John, Coldbrook,—*Hay.*" (Fowler, in Bull. Nat. Hist. Soc. N. B., No. IV.)

3.—C. MONTANA, *Bernh.* Abundant for about one hundred yards along a spring brook, which ran through spruce woods, about ten miles from the H. B. Co.'s. post on Lake Mistassini, N. E. Terr.—*J. M. Macoun.* A few yards of soil on either side of the creek was covered with thick moss, in which, and up to the edge of the stream, grew the fern, the roots in some cases growing right in the water. Some of the specimens were very large, measuring about twenty inches in height.

Genus XVI.—ONOCLEA, *L.*

1.—O. SENSIBILIS, *L., var.* OBTUSILOBATA, *Torr.* "Richibucto,—*Fowler;* Havelock, King's Co.,—*Brittain.*" (Fowler, in Bull. Nat. Hist. Soc. N. B., No. IV.)

Genus XVII.—WOODSIA, *R. Br.*

1.—W. GLABELLA, *R. Br.* In Rev. J. Fowler's new list of New Brunswick plants

(Bull. Nat. Hist. Soc. N. B., No. IV.) the specimens collected at the Tunnel in Restigouche by Mr. Fowler, and at Grand Falls by Mr. Jack, are named *W. hyperborea.* Mr. Jack's Grand Falls plant, however, which I have examined, is undoubtedly true *W. glabella.*

4.—W. OBTUSA, *Torr.* A specimen collected amongst loose rocks at Port Simpson, on Portland Inlet, Northern B. Col., and supplied by Mr. J. R. Anderson, has broad though very thin indusia and so is undoubtedly genuine *W. obtusa.* This important discovery renders it possible that Dr. Lyall's plants, collected on the Galton Mountains, B. Col., in 1861, may after all be this species, and not *W. scopulina,* as was stated in "Canadian Filicineæ" (Trans. Roy. Soc. Can., Vol. II, Sect. IV, p. 174), Professor Eaton, with whom I have communicated on the subject, informing me, that he has never personally examined Dr. Lyall's specimens. Our known stations for this rare Canadian fern are now, therefore, two in number, and strangely far apart, the one being in Nova Scotia, the other in British Columbia.

5.—W. SCOPULINA, *D. C. Eaton.* Specimens, thickly glandular on the upper as well as the lower surface, have been received from Mr. Anderson, who says it grows abundantly amongst loose rocks on Mount Finlayson and other hills about Victoria, B. Col.

6.—W. OREGANA, *D. C. Eaton.* The range of this species has been extended along the Thompson River to Kamloops, B. Col., where typical specimens, but of rather stunted growth, were collected in crevices of dry rocks exposed to intense heat and sunlight, by Mr. Jas. Fletcher of Ottawa, in June, 1885.

Genus XX.—OSMUNDA, *L.*

1.—O. REGALIS, *L.* Abundant around Lake Mistassini, N. E. Terr.—*J. M. Macoun.*

2.—O. CLAYTONIANA, *L.* Very abundant among boulders all around the margin of Lake Mistassini, N. E. Terr., and back from the lake in woods on higher ground.—*J. M. Macoun.*

III.—*On the Fossil Plants of the Laramie Formation of Canada.*

By SIR J. WILLIAM DAWSON, C.M.G., LL.D., F.R.S.

(Presented May 27, 1886.)

I.—INTRODUCTORY.

The following paper is a continuation, and in so far a completion, of those on the Mesozoic Floras of Canada contained in Vols. I and III of these Transactions.

On the geological map of Canada, the Laramie series, formerly known as the Lignitic or Lignite Tertiary, occurs, with the exception of a few outliers, in two large areas west of the 100th meridian, and separated from each other by a tract of older Cretaceous rocks, over which the Laramie beds may have extended, before the later denudation of the region.

The most eastern of these areas, that of the Souris River and Wood Mountain, extends for some distance along the United States boundary, between the 102nd and 109th meridians, and reaches northward to about thirty miles south of the "elbow" of the South Saskatchewan River, which is on the parallel of 51° north. In this area, the lowest beds of the Laramie are seen to rest on those of the Fox Hill group of the Upper Cretaceous, and at one point on the west they are overlaid by beds of Miocene Tertiary age, observed by Mr. McConnell, of the Geological Survey, in the Cypress Hills, and referred by Cope, on the evidence of mammalian remains, to the White River division of the United States geologists, which is regarded by them as Lower Miocene.[1] The age of the Laramie beds is thus stratigraphically determined to be between the Fox Hill Cretaceous and the Lower Miocene. They are also undoubtedly continuous with the Fort Union group of the United States geologists on the other side of the international boundary, and they contain similar fossil plants. They are divisible into two groups,—a lower, mostly argillaceous, and to which the name of "Bad Lands beds" may be given from the "bad lands" of Wood Mountain where they are well exposed, and an upper, partly arenaceous member, which may be named the Souris River or Porcupine Creek division. In the lower division are found reptilian remains of Upper Cretaceous type, with some fish remains more nearly akin to those of the Eocene.[2] Neither division has as yet afforded mammalian remains.

The western area is of still larger dimensions, and extends along the eastern base of the Rocky Mountains from the United States boundary to about the 55th parallel of latitude, and stretches eastward to the 111th Meridian. In this area and more especially in its southern part, the officers of the Geological Survey of Canada have recognized three

[1] Report of Geol. Survey of Canada, 1885.

[2] Cope in Dr. G. M. Dawson's Report on 49th parallel.

divisions as follows:—(1) The Lower Laramie or St. Mary River series, corresponding in its character and fossils to the Lower or Bad Lands division of the other area. (2) A Middle division, the Willow Creek beds, consisting of clays, mostly reddish, and not recognized in the other area. (3) The Upper Laramie or Porcupine Hills division, corresponding in fossils and to some extent in mineral character to the Souris River beds of the eastern area.

The fossil plants collected by Dr. G. M. Dawson in the eastern area were noticed by the writer in an appendix to Dr. Dawson's Report on the 49th parallel, in 1875, and a collection subsequently made by Dr. Selwyn was described in the report of the Geological Survey of Canada for 1879-80. Those of the western area, and especially collections made by myself near Calgary in 1883, were shortly noticed in my paper in Vol. III of these Transactions. The present paper includes a revision of this former work, with the results of the study of new material collected, principally by Mr. J. B. Tyrrell and Mr. T. C. Weston of the Geological Survey, in the western area, and submitted to me along with the previous collections by the Director of the Geological Survey.

In studying these fossil plants, I have found that there is a close correspondence between those of the Lower and Upper Laramie in the two areas above referred to respectively, and that the flora of the Lower Laramie is somewhat distinct from that of the Upper, the former being especially rich in certain aquatic plants, and the latter much more copious on the whole, and much more rich in remains of forest trees. This is, however, possibly an effect rather of local conditions than of any considerable change in the flora, since some Upper Laramie forms recur as low as the Belly River series of the Cretaceous, which is believed on stratigraphical grounds to be considerably older than the Lower Laramie.

With reference to the correlation of these beds with those of the United States, some difficulty has arisen from the tendency of palæobotanists to refer the plants of the Upper Laramie to the Miocene age, although in the reports of Mr. Clarence King, the late Director of the United States Geological Survey, these beds are classed on the evidence of stratigraphy and animal fossils, as Upper Cretaceous. More recently, however, and partly perhaps in consequence of the views maintained by the writer since 1875, some change of opinion has occurred, and Dr. Newberry and Mr. Lesquereux seem now inclined to admit that what in Canada we recognize as Upper Laramie, is really Eocene, and the Lower Laramie either Cretaceous or a transition group between this and the Eocene. In a recent paper,[1] Dr. Newberry gives a comparative table, in which he correlates the Lower Laramie with the Upper Cretaceous of Vancouver Island and the Faxœ and Maestricht beds of Europe, while he regards the Upper Laramie as equivalent to European Eocene. Except in so far as the equivalence of the Lower Laramie and Vancouver Island beds is concerned, this corresponds very nearly with the conclusions of the writer in his paper read to this Society last year,[2] namely, that we must either regard the Laramie as a transition Cretaceo-Eocene group, or must institute our line of separation in the Willow Creek or Middle Laramie division, which has, however, as yet afforded no fossil plants. I doubt, however, the equivalence of the Vancouver beds and the Lower Laramie, except

[1] Newberry, Trans. N. Y. Academy, Feb., 1886.

[2] *Ibid.*, Vol. iii.

perhaps in so far as the upper member of the former is concerned.[1] I have also to observe that in the latest report of Mr. Lesquereux[2] he still seems to retain in the Miocene certain formations in the west, which from their fossil plants I should be inclined to regard as Eocene.

In my original studies of the specimens described in this paper, I had examined and noted separately the collections from the eastern and western areas; but as these obviously correspond in their divisions, and several of the species are identical, I have, to avoid repetition, placed the whole together; noting, however, the localities in which the specimens were obtained, and their reference to the Lower or Upper divisions.

I may state here my obligations to the reports of Lesquereux on the Tertiary Flora of the United States, and more especially to Dr. Newberry's Memoir on the Later Extinct Floras of America,[3] and to the volume of plates published in illustration of it by the United States Geological Survey [4] as these, referring to localities adjoining the Canadian boundary and to beds continuous with ours, have proved of the greatest value for purposes of comparison.

II.—Descriptions of Species.

1. *Filices.*

Onoclea sensibilis, *Linn.*

Newberry, Later Extinct Floras of America, p. 39, and Volume of Illustrations, published by the Geological Survey of the Territories of the United States, 1878. Report by Dr. G. M. Dawson, on the Geology of the 49th Parallel, Appendix A.

Leaves of this species are abundant in the beds of Porcupine Creek, (long. 106°) near the international boundary, which are of Upper Laramie age. They are also found in the Lower Laramie of the same district at the Bad Lands of Wood Mountain. The species has also been recognized in the plant beds of the Isle of Mull on the Scottish coast. These were at one time regarded as Miocene, but are now recognized by Mr. Starkie Gardiner as Eocene. It is a very common American fern at the present day, ranging from Northern Canada to Pennsylvania and southward, and from the Atlantic coast into the interior. It vindicates its claim to be a long-lived species by its present wide distribution, and the considerable varieties of station in which it can flourish. Though living in America it has become extinct in Europe. Newberry describes it from the Fort Union group, in which, as well as at Porcupine Creek, it is very abundant. Dr. Newberry notices the fact that the fossil fronds are intermediate between the common modern variety and var. *obtusiloba* of Torrey.

Collected by Dr. G. M. Dawson, whose collections in the remainder of the paper will be indicated by the letters G. M. D.

Davallia (Stenoloma) tenuifolia, *Linn.* (Plate I, Fig. 1.)

Report on 49th Parallel, p. 329, Pl. XVI, Figs. 1 and 2.

This species is found at Porcupine Creek with the preceding, but is more rare. I

[1] Protection Island beds of my paper, Trans. Roy. Soc. Can., Vol. i.

[2] Cretaceous and Tertiary Plants.

[3] Annals of New York Lyceum, 1868.

[4] Illustrations of Cretaceous and Tertiary Plants, 1878.

have compared this plant with recent specimens from the Himalayas in the collection of Mr. D. A. P. Watt of Montreal, and find no difference. The genus is not now known to be represented in America. Ferns of this type are not uncommon in the early Tertiary of other countries, but being known only by barren fronds have usually been referred to the genus *Sphenopteris*. *Sphenopteris Brunstrandi* of Heer, from the so-called Miocene of Spitzbergen is one of these species, and also *S. eocenica* of Ettingshausen.

In regard to distribution, this plant affords a curious contrast to the last. It is now confined to Asia, whereas in the Laramie period it was associated in America with our common Onoclea. It has not been found in the Laramie of the United States.

Collected by G. M. D.

2. *Equisetaceæ.*

EQUISETUM, Sp.

In the Upper Laramie of Porcupine Creek, are many fragments of stems of an Equisetum about a quarter of an inch in diameter, and with twenty to thirty ribs. It is near to *E. arcticum* of Heer, from Spitzbergen, and to *E. Wyomingense* of Lesquereux, but cannot be certainly identified.

Collected by G. M. D.

EQUISETUM, (Roots and bulblets). (Plate I, Fig. 2).

Physagenia Parlatorii, Report of 49th Parallel, p. 329, Pl. XVI, Figs. 3 and 4.

There can be little doubt that the plants designated by Heer, *Physagenia*, are really roots and tubers of Equisetum. The specimens are from the Upper Laramie of Great Valley (lat. 49°, long. 105°); but these objects occur in this formation in various places in Canada and the United States.

Collected by G. M. D.

3. *Coniferæ.*

THUJA INTERRUPTA, *Newberry*. (Plate I, Fig. 3).

Newberry, *loc. cit.* p. 42. Dawson, Report on 49th Parallel, Ap. A.

This species is, according to Newberry, very characteristic of the Fort Union group, and is equally so of the Upper Laramie at Porcupine Creek. One of the specimens shows scales of the cone, which resemble those of *T. gigantea* of the west coast, while the foliage is nearer to that of *T. occidentalis*, the common "cedar" or arbor-vitæ of Canada. Wood, having the structure of that of Thuja, is found in the lignites associated with these beds, and probably belongs to this species.

Collected by G. M. D.

SEQUOIA NORDENSKIOLDII, *Heer*.

Heer, Flora Foss. Arctica (Spitzbergen.)

The common species of Sequoia found at Porcupine Creek and Great Valley seems referable to this species, and it is still more abundant in the same Upper Laramie formation at Red Deer River. Specimens of the same species from the Fort Union group, presented to me by Dr. Newberry, are labelled as this species, though in his memoir *S. Langsdorffii* alone is mentioned. Our specimens cannot be distinguished from those from Spitzbergen figured by Heer, though in form and size the leaves are somewhat variable. Cones also

are found, which, so far as can be made out, are similar to those described and figured by Heer. Some of the specimens might, it is true, be referred to *S. Langsdorffii*, but there seem so many gradations that I doubt if any specific distinction can be made out. I have already indicated in Vol. III of these Transactions that the specimens from Vancouver Island which have been referred to *S. Langsdorffii*, probably belong to *S. Smittiana* of Heer, a Cretaceous species.

This species also occurs on the Mackenzie (Richardson). Along with *S. Langsdorffii*, it is abundantly distributed in the older Tertiary of Europe and America. So far as known, it is limited in Canada to the Laramie series.

Porcupine Creek and Great Valley, collected by G. M. D.; Cones, Dirt Hills, collected by R. Bell; Red Deer River and Bow River, J. B. Tyrrell.

GLYPTOSTROBUS EUROPEUS, *Brngt.*

Heer, Flora Helvetica.

Fragments of branches and of strobiles, referable, though not very certainly, to this species in its wider acceptation among palæobotanists, occur in the Upper Laramie of Porcupine Creek. It is found, according to Newberry, in the Fort Union group of Dakota, and also, according to Heer, in the so-called Miocene of Greenland. Cones, probably of Glyptostrobus, occur rarely in the Porcupine Hill beds.

Collected by G. M. D.

TAXODIUM OCCIDENTALE, *Newberry.*

Newberry, *loc. cit.*

This species is found in the eastern division of the Laramie (Selwyn); and in the western division, fragments probably referable to it have been found in several places.

TAXITES OLRIKI, *Heer.* (Pl. I, Fig. 5.)

Heer, Flora Alaskana, Flora Foss. Arctica, Report of Geological Survey of Canada, 1879-80.

Leaves and branches referable to this fine species, collected by Dr. Selwyn in the sandstones of the Upper Laramie at Roche Percée, Souris River, were noticed by the writer in the report of the Geological Survey of Canada of 1879-80. It was originally described by Heer, from Alaska and Spitzbergen, and does not seem to have been noticed in the Laramie of the United States. It may have been a northern form.

SALISBURIA, Sp.

At least one species of Salisburia belongs to our Laramie Flora. Nutlets occur in some of Mr. Tyrrell's specimens from the Lower Laramie, and fragments of leaves and also nutlets were collected by the writer in the Upper Laramie sandstone of Shaganappi Point near Calgary. In so far as venation is concerned, these leaves might belong to Lesquereux's species *S. polymorpha;* but their size and form cannot be made out any further than that they represent a broad-leaved species not unlike the modern *S. adiantoides.*

4. *Monocotyledones.*

LEMNA (SPIRODELA) SCUTATA, *Dawson.* (Pl. I, Fig. 6.)

Report on 49th Parallel, p. 529, Pl. XVI, Figs. 5 and 6. Lesquereux, Tertiary Flora.

Fronds, round, kidney-form or sometimes tending to trilobed, undulate at the edges; half an inch to nearly an inch in diameter. Single or grouped, veinless or with very faint veins radiating from a marginal spot Roots long, filiform, proceeding apparently from a slight notch on the edge of the frond.

This was evidently an aquatic plant, producing rounded or rarely trilobed fronds about three-quarters of an inch in diameter, and having numerous rootlets proceeding from a marginal or submarginal thickened spot. The fronds were evidently fleshy but not vesicular, and cellular with extremely delicate radiating veins which can seldom be seen. Whether this plant is truly a Lemna it is impossible to decide, in the absence of fructification, but I feel certain that it should not be confounded with Lesquereux's *Pistia corrugata*, with which that botanist compares it. This I have not seen, but as figured by him it differs in size, form, and venation.

The plant is plentiful and very constant in its characters in the Lower Laramie of the Bad Lands of Wood Mountain (G. M. D.); also in the Lower Laramie of Pincher Creek (T. C. Weston).

PHRAGMITES, Sp.

Many leaves referable to plants of this genus occur in all the collections, from both Upper and Lower Laramie, but can only be characterized as stems and leaves of large grass-like or sedge-like plants of uncertain affinities.

SCIRPUS, Sp.

Report on 49th Parallel.

Spikes small, numerous, less than a line long, and with from four to five pairs of incurved lanceolate scales.

Lower Laramie, Bad Lands of Wood Mountain.

Collected by G. M. D.

SCIRPUS, Sp.

Report on 49th Parallel.

Spikes with about six pairs of scales and about two lines long.

Upper Laramie, Porcupine Creek.

Collected by G. M. D.

5. *Dicotyledones.*

PLATANUS NOBILIS, *Newberry.* (Plate I, Fig. 7.)

Newberry, Later Extinct Floras; Dawson in Report Geol. Survey of Canada, 1879-80.

This magnificent leaf, of which many very good specimens have been obtained, was first described by Dr. Newberry in the Annals of the Lyceum of New York for 1868. His specimens were from the Fort Union series, near Fort Clarke, on the Upper Missouri, and were found in beds then regarded as Miocene Tertiary, though now known to be much older, and which are on the horizon of the Lignite Tertiary series of the Souris River. A figure of the leaf is given in Dr. Newberry's later work, "Illustrations of Cretaceous and Tertiary Plants," Geological Survey of the Territories, 1878. There can be little doubt that this plant is the same with that named by Lesquereux, *Platanus dubia*, in 1878, and subsequently described in his report on the Tertiary Flora of the Western Territories, as

Aralia notata. Fragments of this leaf were obtained by Dr. G. M. Dawson in the region of the Souris River in 1874, but they were too imperfect for description. Dr. Selwyn, however, found in 1878 in the Upper Laramie sandstones of Roche Percée, on Souris River, very perfect specimens, which I noticed in the Report of the Geological Survey for 1879-80, Dr. Selwyn having kindly placed his specimens in my hands for study. Some of these are a foot in diameter, and they show some points of structure not before noticed.

I may, before referring to these, quote Newberry's description, which is very full and accurate.

" Leaves large, one and a half feet in length and breadth, petioled, 3 lobed, or sub-5 lobed, lobes acute, margins of lobes and base entire, or near the summits of the lobes delicately sinuate-toothed; nervation strongly marked, generally parallel; medial nerve straight, two basilar nerves of nearly equal length and strength diverge from it at an angle of 30°-35°, are straight throughout and terminate in the apices of the principal lateral lobes. Above the basilar nerves about 16 pairs of lateral nerves are given off from the midrib at about the same angle; these are nearly straight and parallel, terminating in the teeth of the margin. From each of the basilar nerves diverge about the same number of pairs of branches as from the mid-rib, and these are nearly straight and parallel terminating directly in the margin. Of these the second and third exterior one on each side, is often much the strongest of the series, and is then prolonged into a small but distinct lateral, triangular, acute lobe, giving the leaf a somewhat pentagonal form. From this basilar branch of the lateral nerves, 12 or more short, generally simple branchlets, spring on the lower side, and 4-5 on the upper side, near the summit, all of which terminate in the margins. The tertiary nerves connect the adjacent secondary nerves nearly at right angles. Sometimes they are straight and parallel, but oftener more or less broken and branching where they meet, near the middle of the interspaces. Where the systems of nervation of the lateral and middle lobes come in contact, the tertiary nerves are stronger and form a somewhat irregular network, of which the areolæ are large and subquadrate."

The above description corresponds perfectly with Dr. Selwyn's specimens, except that only the right basilar nerve sends off a large branch terminating in a lobe; that on the left side having somewhat equal branches.

As to the affinities of the leaf, Newberry remarks that the texture is thicker and the surface smoother than most sycamores, resembling in this some tropical leaves; but as the radical structure is that of *Platanus*, and the associated plants indicate a temperate climate, he refers the plant to that genus.

Lesquereux, in describing his *Aralia notata*, gives nearly the same characters, except that he characterizes the secondary nerves as camptodrome, or bending before they reach the margin. He admits that he would consider it identical with Newberry's species but for this feature, and further adds that in one of his specimens the outer veins appear to be craspedodrome and to terminate in small teeth, and he refers to other cases in which such characters are inconstant. In Dr. Selwyn's specimens, while in the basal part of the leaf the veins bend somewhat toward the margin, which is entire, in the upper part they run straight to the margin, and terminate in short teeth, separated by broad, shallow sinuses. Thus these specimens satisfactorily unite Newberry's and Lesquereux's species.

Dr. Selwyn's specimens, however, and others subsequently collected by myself at

Shaganappi Point, exhibit a peculiarity which seems to have been absent or concealed in the specimens studied by Newberry and Lesquereux, in the presence of two short basal lobes, extending backward on the petiole. Each of these is about an inch in length, pointed, and with one strong exterior tooth and two delicate nerves, one extending to the point and the other to the tooth. It does not certainly appear whether these basilar lobes are separate or united in the middle. If the latter, they would present some resemblance in mode of attachment to the Cretaceous leaves known as *Protophyllum*, and to the Tertiary species of Pterospermites, from which, however, this leaf differs materially in other respects. These peculiar basal lobes are preserved only in a few of the specimens.

In Dr. Selwyn's specimens the petiole is four inches long in a specimen about a foot in diameter. It is channelled, woody in texture, and with an articulating surface at the proximal end. This and its great abundance on certain surfaces, shows that the leaf belonged to a deciduous tree, which, from the localities cited by the authors already named, must have been widely distributed, though as Lesquereux remarks, especially abundant to the north.

It is to be hoped that further research will disclose the fruit of this remarkable tree, and thus make its affinities more certainly known. In the meantime, I think it well to retain Newberry's name, as having priority, and quite as likely to be correct as any other. If a Platanus, the tree must, as Newberry remarks, have borne somewhat the same relations to our sycamores which *Acer macrophyllum* of the West Coast bears to the other maples. This species would seem to be specially abundant in the "Second Group" (Evanston, Mount Brosse, etc.) of Lesquereux's arrangement of the Lignitic flora.

In the sandstones and shale of the Upper Laramie at Shaganappi Point, near Calgary, I found these leaves very abundant, and showing the same characters with Dr. Selwyn's specimens from the Souris. Fragments referable to this species also appear in Mr. Tyrrell's collections from another locality on the Bow River, and from disturbed beds in the foot-hills to the north; and a very similar, if not the same species, occurs in the Belly River series, near Medicine Hat.

PLATANUS RAYNOLDSII, *Newberry.*

Newberry, *loc. cit.* Lesquereux, Tertiary Flora. Dawson, *loc. cit.*

Very abundant with the last at Shaganappi Point. The leaves present many differences in size and form, but all of these fall within the limits of the descriptions and figures of Newberry and Lesquereux. This is a well known species of the Fort Union division in the United States.

Collected by G. M. D.

PLATANUS HAYDENII, *Newberry.*

Newberry, *loc. cit.* Lesquereux, Tertiary Flora.

A leaf not well preserved, but identical, so far as venation and general form are concerned, with the Fort Union species named above, occurs in Mr. Tyrrell's collections from sandstones of the Upper Laramie on the Bow River. It is associated with leaves of *P. nobilis.*

CORYLUS ROSTRATA, *Ait.*

Newberry, *loc. cit.* Report on 49th Parallel.

Specimens of leaves so near to the above modern species that they cannot be separated from it occur on the Upper Laramie of Porcupine Creek. Newberry has recognized this species in the Fort Union group.

Collected by G. M. D.

CORYLUS MCQUARRII, *Heer.*

Heer, Flora Foss. Arctica.

Fragments pretty certainly belonging to this species appear in the collections from the Upper Laramie of Porcupine Creek. The species occurs in the Fort Union group, on Mackenzie River, and also in the so-called Miocene of Alaska and Greenland.

Collected by G. M. D.

CASTANEA, Sp.

Quercus. Report Geol. Survey of Canada, 1879-80.

Leaf elongate oblong, margin obtusely dentate at ends of veins, which are rather less than a quarter of an inch apart, and at angle of 45° to 47°. Texture coriaceous.

This leaf occurs in the Upper Laramie of Souris River. It may be the same with Lesquereux's *C. intermedia.*

Collected by Dr. Selwyn.

QUERCUS, Sp. (Plate I, Fig. 8.)

Leaf long, narrow, with simple straight nerves and entire edges.

Upper Laramie of Great Valley.

Collected by G. M. D.

POPULUS GENETRIX, *Newberry.*

Newberry, *loc. cit.*

In the Upper Laramie of Souris River, Great Valley and Shaganappi Point. In the publications of Lesquereux and Newberry there are several nearly allied species to which this leaf may have belonged; but Newberry's figure, named as above, has the same characters.

POPULUS ACERIFOLIA, *Newberry.*

Newberry, *loc. cit.*

Found in Dr. Selwyn's collections from Souris River; also in Mr. Tyrrell's collections from the foot-hills of the Rocky Mountains, north of Bow River, and in my collections from Shaganappi Point.

POPULUS RICHARDSONII, *Heer.*

Fragments of leaves from the Upper Laramie of Porcupine Creek appear to represent this species, also found on Mackenzie River.

Collected by G. M. D.

POPULUS ARCTICA, *Heer.* (Plate I, Fig. 9.)

Heer, Flora Foss. Arctica. Newberry, *loc. cit.*

In the specimens in my possession I cannot certainly separate *P. arctica* from leaves having the character of *P. cuneata* of Newberry, which may be merely a smaller form.

Great Valley, G. M. D. Souris River, Dr. Selwyn.

SALIX RAEANA, *Heer.*

Heer, Flora Foss. Arctica.

This species, occurring in Greenland and on the Mackenzie River, is represented by a few specimens in the collections from Great Valley.

Collected by G. M. D.

SALIX LARAMIANA, S. N. (Plate I, Fig. 10).

Leaf moderately large and wide, veins few, at angle of 45°, forking at an obtuse angle toward the margin, which is entire, surface finely reticulate.

This species, except in its entire margin, resembles very nearly the *S. varians*, Heer, from Alaska. It occurs in the Upper Laramie of Great Valley.

Collected by G. M. D.

ULMUS PRÆCURSOR, S. N. (Plate II, Fig. 11).

Leaves small, thin, inequilateral and rounded at the base. Apex acute, margin sinuate. Veins numerous, slightly curved, and dividing toward the margin to enter into the unequal serrations.

This species is nearly related to the *U. tenuinervis* of Lesquereux, from Florissant, Colorado. It does not seem to have been found in the recognized Laramie or Fort Union group of the United States.

SASSAFRAS (ARALIOPSIS) BURPEANUM, *Dawson.* (Plate II, Fig. 12).

Dawson, Mesozoic Floras, Trans. Roy. Soc. Can., Vol. III.

This leaf will be found described in the paper above cited. It is from the Upper Laramie of Shaganappi Point, and is named after Mr. Burpee, who aided in my explorations there.

SASSAFRAS SELWYNII, *Dawson.* (Pl. II, Fig. 13).

Dawson, Report Geol. Survey of Canada, 1879-80.

Leaf somewhat rough on the under side; three lobed, three ribbed, with the central lobe longest; ribs and nerves strong and woody; margin entire and slightly waved; breadth, 4·5 centimetres; length, 5 centimetres. The two lateral nerves diverge at an angle of 40° from the midrib. Each lateral rib gives off three small curved veins at its base, and these six strong curved veinlets which bend round and become parallel with the margin. Slender parallel veins are given off from the inner sides of the lateral ribs, and join those of the midrib up to a height of 1·5 centimetres, when the midrib gives off 6 strong slightly curved parallel lateral veins on each side, at angles of 40°.

This species is represented by only one well-preserved example and some fragments, in Dr. Selwyn's collections from the Souris River. Its form and venation are very peculiar, and I think entitle it to be referred to *Sassafras* with quite as much probability as many of the leaves from the Cretaceous referred to that genus. It is indeed very near to *S. cretaceum*, Newberry, especially the variety *obtusum* of Lesquereux. It is to be observed, however, that this common Cretaceous species has also been referred to *Araliopsis.* If a Sassafras, it is of interest as being the first representative of that genus in the Laramie period.

Collected by Dr. Selwyn.

VIBURNUM ASPERUM, *Newberry.*

This Fort Union Species is quite abundant in the Upper Laramie of Red Deer River. Fragments also occur in the Souris River collection and in those from Shaganappi Point, where are also fruits which may have belonged to some species of Viburnum. It also occurs at Porcupine Creek.

VIBURNUM CALGARIANUM, *Dawson.* (Plate II, Fig. 14.)

Described in the Transactions of the Royal Society of Canada, Vol. III, from specimens collected at Shaganappi Point.

VIBURNUM OXYCOCCOIDES, *Dawson.* (Plate II, Fig. 15.)

Described as above from specimens collected at Shaganappi Point. Accompanied by fruits like those of Viburnum. This species is very near to the modern *V. opulus.*

VIBURNUM LANCEOLATUM, *Newberry.*

Newberry, *loc. cit.*

A leaf from Porcupine Creek seems to represent this Fort Union species.

CATALPA CRASSIFOLIA, *Newberry.*

Fragments of leaves in the Upper Laramie of Bow River are similar to the above species, whose generic relations are doubtful.

Collected by J. B. Tyrrell.

SAPINDUS AFFINIS, *Newberry.*

Newberry, *loc. cit.*

Leaves of this characteristic Fort Union species occur in the Lower Laramie of the Bad Lands of Wood Mountain, and also in the Upper Laramie of Great Valley.

Collected by G. M. D.

ÆSCULUS ANTIQUA, *Dawson.* (Plate II, Fig. 16.)

Report on 49th Parallel, 1875.

Pericarp 1½ inches in length and one inch in breadth; obovate, truncate at the base, regularly rounded above with several strong woody spines on the upper half. Seed of similar form, but smooth or with a few tortuous impressions. This fruit seems to be an Æsculus, but with characters somewhat intermediate between those of the horse-chesnut and those of the American buckeye.

Lower Laramie, Bad Lands, Wood Mountain.

Collected by G. M. D.

SYMPHOROCARPOPHYLLUM, G. N.

I place under this name certain leaves from the Upper Laramie of Great Valley, which at first I had named *Hederophyllum*, but now find them so near in form, venation and texture to the leaves of the common snowberry that I can scarcely doubt their affinity to these. On the same slabs there are remains of berry-like fruits, which probably belong to some caprifoliaceous plant, and possibly to the species described below.

SYMPHOROCARPOPHYLLUM ALBERTUM, S. N. (Plate II, Fig. 17.)

Leaf about an inch in length, obovate, pointed below, rounded at apex, with two blunt teeth on the sides. Midrib obscure, veins at very acute angles and evanescent, surface finely netted. Upper Laramie of Great Valley.

Collected by G. M. D.

S. LINNÆIFORME, S. N. (Plate II, Fig. 18.)

Leaf very small, rounded, with five very obtuse lobes, the terminal lobe by much the largest. The leaves are tortuous and dichotomous, with a fine reticulation between. Has much the general aspect of the leaf of *Linnæa borealis.* Upper Laramie, Porcupine Creek.

Collected by G. M. D.

PALIURUS COLOMBI, *Heer.*

Heer, Flora Foss. Arctica. Lesquereux, Tertiary Flora.

Described originally by Heer from Greenland and Spitzbergen, and found along with *Populus arctica* at Carbon, Wyoming. Upper Laramie, Great Valley.

Collected by G. M. D.

CARYA ANTIQUORUM, *Newberry.*

Newberry, *loc. cit.* Lesquereux, Tertiary Flora.

Described by Newberry from the Fort Union beds, in which its leaves are abundant. Lesquereux finds it in the Yellowstone Valley and at Evanston. Upper Laramie of Porcupine Creek.

Collected by G. M. D.

JUGLANS RUGOSA, *Lesquereux.*

Lesquereux, Tertiary Flora.

In the Report on the 49th Parallel I referred these leaves to *Juglans nigella* of Heer, but they are still nearer to Lesquereux's figures, if these represent a true species and not merely a varietal form.

In confirmation of the reference of this and the following species to Juglans, I may mention that, in some of the silicified wood of the district which affords the leaves, there are trunks which have been sliced by Mr. Weston and show the structure of the modern butternut. Porcupine Creek, Upper Laramie.

Collected by G. M. D.

JUGLANS SCHIMPERI, *Lesquereux.*

Lesquereux, Tertiary Flora.

Lesquereux's description is as follows:—"Leaves lanceolate, gradually acuminate, broadly cuneate, and rounded at the inequilateral base to a short petiole; borders slightly undulate, secondary veins numerous, parallel, curved, closely following the borders, nervilles distant, areolation subquadrate." Leaves answering to this description occurs in the Upper Laramie shale of Great Valley. Lesquereux's specimens were from the Green River group, which is reported as typical Eocene, and may be newer than the Upper Laramie.

Collected by G. M. D.

JUGLANS RHAMNOIDES, *Lesquereux.*

Lesquereux, Tertiary Flora.

This species is thus described by Lesquereux :—" Leaves oval, narrowed in a curve or rounded to the petiole, very entire ; lateral veins thin, distant, curved in passing to the borders, camptodrome."

Lesquereux's specimens were from Spring Cañon, Montana, also Black Butte, Wyoming, and Point of Rocks, Wyoming, all belonging to his Lower Lignitic or Laramie group, and he regards Newberry's species from the Fort Union group, *Cornus acuminata*, as the same. The species is closely related to, if not identical with, *Juglans acuminata*, Brongt., of the European Tertiary. My specimens are from the Upper Laramie, Porcupine Creek.

Collected by G. M. D.

TRAPA BOREALIS, *Heer.* (Plate II, Fig. 19).

TRAPA MICROPHYLLA, *Lesquereux.*

Heer, Flora Alaskana. Dawson, Report on 49th Parallel, 1875. Lesquereux, Tertiary Flora.

Fruits of *Trapa*, or water chestnut, referred by me to Heer's Alaska species, were recognized in 1876 in the collections of Dr. G. M. Dawson from the 49th parallel, from beds belonging to the Lower Laramie group. More recently, Lesquereux has found, in beds probably of Laramie age at Point of Rocks, leaves which he has named *Trapa microphylla*, and attributes to this genus. In Mr. Tyrrell's collections from the Red Deer and Rosebud Rivers, there are fruits similar to those of Heer's species, and leaves not distinguishable from those described and figured by Lesquereux. We have thus a probability that the fruits and leaves belong to the same species.

Lesquereux's description of the leaves is as follows :—" Leaves small, (round ?) or broadly ovate and obtusely rounded to the petiole, borders denticulate from below the middle upward, nervation ternate from the top of the petiole, or irregularly pinnate, lateral nerves at an acute angle (15° to 20°), flexuous with dichotomous branches, all craspedodrome, areolation distinct, polygonal, minute, by subdivisions of the veinlets at an acute angle." Heer's description of the fruit is as follows :—" Nuts two-horned, narrowed at base, striate longitudinally, widened in the middle, with two spines which are long, divergent and acute ; the apex exsert and narrowed."

These fruits and leaves are all from the Lower Laramie, with the exception of one doubtful example from the Upper Laramie of Great Valley. The localities are Bad Lands. (G. M. D.) Red-deer and Rosebud Rivers (Tyrrell), and Pincher Creek (Weston). In some of these localities the leaves and fruits occur together, and in some they are associated with *Lemna scutata* and Phragmites.

The leaves seem to be very variable in form and dimensions, and in Mr. Tyrrell's collections there are fragments of much larger leaves than any figured by Lesquereux.

PHYLLITES VENOSUS, *Newberry.*

Newberry, *loc. cit.*

A leaf of very uncertain affinities ; but it furnishes another point of accordance between the Canadian Laramie and the Fort Union group, Upper Laramie, Porcupine Creek. Collected by G. M. D.

PHYLLITES, Sp. (Pl. II, Fig. 20).

This is a small oblong leaf, with a mid-rib and a few veins curving toward the margin. Near the apex, the sides suddenly curve inward, giving a shouldered or almost three toothed aspect. Upper Laramie, Great Valley.

Collected by G. M. D.

PHYLLITES CAPARINOIDES, *Newberry.*

Newberry, *loc. cit.*

Another uncertain species common to the Fort Union and Upper Laramie of Great Valley.

Collected by G. M. D.

CARPOLITHES, Sp.

In Mr. Tyrrell's collections from Antler Hill, probably Upper Laramie, are several kinds of fruits, some of which seem to have been smooth two-valved nuts, and others drupes, like those of Viburnum. They are not sufficiently perfect for certain determination; but the locality is one deserving the attention of collectors, as likely to afford useful information respecting the fruits of the trees of the Laramie forests. It is an interesting but somewhat unfortunate circumstance that the sorting action of water has usually distributed fruits in different places from the leaves of the same plants.

III.—GENERAL REMARKS.

As the relation of the Belly River series (which on stratigraphical grounds is regarded as inferior in position to the Fort Pierre group) to the Laramie is of some interest, it may be well to state here that this series closely resembles the Lower Laramie in its physical features and in its fossils. The number of species which it has afforded is, however, small, and about half of these are distinct from those of the Laramie.

The species observed in the collections from this group are the following:—

Sequoia Reichenbachii, *Heer.*
Salisburia? fruits of
* Lemna scutata, *Dawson.* (Trans. Roy. Soc. Can., III.)
Brasenia antiqua, *Dawson.* (*Ib.*)
* Platanus nobilis, *Newberry.*
Acer Saskatchewense, *Dawson.* (*Ib.*)
* Populus acerifolia, *Newberry.*
" latidentata, *Dawson.* (*Ib.*)
Trapa (*probably* T. borealis), *Heer.*

These few species are scarcely sufficient to afford a basis for definite conclusions. Those marked with asterisks are found in the Laramie. The others are distinct, but their general aspect does not indicate any great difference of age. It is to be hoped that further explorations may disclose a larger number of species, but sufficient is known to indicate that the conditions of deposit and of vegetable life were very similar.

Of the plants found in the Laramie itself only the following occur in the lower division, those marked with asterisks being found in both divisions:—

* Onoclea sensibilis, *Linn.*
* Lemna scutata, *Dawson.*
* Phragmites, Sp.
* Scirpus, Sp.
* Sapindus affinis, *Newberry.*
Æsculus antiqua, *Dawson.*
* Trapa borealis, *Heer.*
Carpolithes.

This little flora bespeaks aquatic conditions not favorable to the preservation of land plants, but showing that exogenous trees, akin to those of the Upper Laramie above and the Cretaceous below, existed. It may be hoped that within our district some locality more prolific in plants may be discovered. The Lower Laramie would seem to correspond with some of the localities in the United States referred by Lesquereux to his first or oldest Tertiary series, though, as already stated, the beds hold remains of Saurians of Cretaceous aspect.

The Upper Laramie flora is decidedly richer, including all the other species described in this paper. Its plants are in the main identical with those of the Fort Union group of the United States geologists, which it would seem that Lesquereux still holds to be of Middle Tertiary age, along with those of the Bad Lands of Dakota and of Carbon, and with the so-called Miocene of Alaska, Greenland and Mackenzie River, as described by Heer. To this I cannot agree. The evidence of stratigraphy and fossils seems to refer all these to the Eocene period. If with Lesquereux we regard the Lower Laramie flora as Lower Eocene, and corresponding to that of Sesanne in Europe, then the Upper Laramie will be Middle or Upper Eocene. If on the other hand the Lower Laramie be regarded as the highest member of the Cretaceous, the Upper Laramie may be Lower Eocene. In the meantime I cannot help believing that, notwithstanding the large amount of material collected, and the valuable work done by the palæobotanists of the United States Geological Survey, there is still some confusion in the arrangement of the successive floras which may require revision in the future.

With this third paper I close for the present my sketches of the Cretaceous and Early Tertiary floras of Canada. I have been induced to leave for a time my favourite Palæozoic plants, and to notice the collections made in the less ancient formations of the west, by the intrinsic interest of the subject, by the wish to trace up the vegetable kingdom in its later stages, and by the belief that some misunderstandings existed which the distinct sequence of formations in this country might clear up.

The material at my disposal has been from several horizons well fixed by geological work, and thus, though not in itself large, its study has I think been fruitful of important results; and when in future the flora of the several successive formations from the Lower Cretaceous to the Eocene shall have been more fully worked out, though what I have been able to do in the infancy of collection in these regions, may be eclipsed by the rich additions which will be made, it will I think be found that a good foundation has been laid for the understanding of the true succession of vegetable life from the earlier Cretaceous onward.

A short explanation may be necessary as to nomenclature. In this I have followed the methods heretofore used by others. I have, however, done so under protest and with certain qualifications as stated in my last paper, to the effect that generic names applied to fragments of plants must be merely tentative and provisional, and that they are liable to large corrections when more perfect specimens shall be procured.

In this matter I sympathise very strongly with Dr. Nathorst in his objection to the use of modern generic names for mere leaves, and would be quite content to adopt some non-committal termination, as that of *-phyllum*, suggested by him. I feel, however, that almost as much is taken for granted if a plant is called *Corylophyllum*, as if called *Corylus*. In either case a judgment is expressed as to its affinities, which if wrong under the one term is wrong under the other, and after so much has been done by so many eminent botanists, it seems inexpedient to change the whole nomenclature for so small and questionable an advantage. I wish it, however, to be distinctly understood that the leaves described in this paper are for the most part referred to certain genera on evidence necessarily imperfect, and their names are, therefore, subject to correction as new facts may be obtained.

In the work which I have done on Palæozoic fossil botany, I have laboured by much digging to get together all the parts of the plants described, though, after doing this, I have often had the mortification to find that botanists accustomed only to hand specimens of fossil plants have regarded my statements with suspicion, as if relating to merely imaginary restorations. In the case of the deciduous trees of the later formations, it is less easy to obtain evidence of this kind, and in the exploration of our Western territories the difficulty of transporting bulky specimens has been too great to allow as much to be done as in the Devonian and Carboniferous districts of the East.

I may add that, since the publication of my first memoir, Dr. G. M. Dawson has made important collections in the Cretaceous coal formation of Vancouver Island. These, while more fully illustrating previously described material, will add a number of new species which await study and illustration.

By the kind permission of Dr. Selwyn, the drawings for this and for the previous paper have been executed by Mr. L. M. Lambe, artist to the Geological Survey.

NOTE.—Owing to the absence of the author when the foregoing sheets were passing through the press, a few trifling errors have occurred which are now corrected.

Page 22, after "THUJA INTERRUPTA," read "(Pl. I. Figs. 3 and 4.)"

" 27, insert "(Pl. I. Fig. 8.)" after "CASTANEA, Sp.," instead of after "QUERCUS, Sp."

" 30, under "S. LINNÆIFORME," read "the veins are tortuous" for "the leaves are tortuous."

In Plate II, Figs. 15 and 18 are in part restorations, in consequence of the best specimens having been mislaid.

IV.—*On the Silurian System of Northern Maine, New Brunswick and Quebec.*

By L. W. BAILEY.

(Read May 27, 1886.)

Since the time of the publication, in 1842, of Dr. A. Gesner's Fourth "Report on the Geology of New Brunswick," the Upper Silurian age of the extensive tract comprising the northern counties of this Province has been generally accepted; the fossils collected from various localities along the St. John River, and again in the counties of Restigouche and Gloucester, indicating an horizon about that of the Niagara or Lower Helderberg formations. In his "Geology of Canada" for 1863, Sir W. E. Logan described at length the same formation, chiefly as found in the Province of Quebec, under the name of the "Gaspé Limestone" series, at the same time referring to its northern base as being found on Lake Temiscouata, where a high ridge abutting upon the lake, known as Mount Wissick or Mount Lennox, and abounding in fossils, was regarded as resting unconformably upon a series of beds at one time supposed to be Devonian, but then referred to the base of the Quebec group. In Northern Maine also the same formation had been early recognized by Jackson, and was subsequently more fully investigated (in 1860) by Packard and Hitchcock, the latter describing the Silurian rocks as found at Lake Sedgewick (Square Lake) and some other points, and which were richly fossiliferous, as being unconformably overlaid by a series of red shales and conglomerates, referred to the Devonian. In the meantime the limits of the formation in New Brunswick remained for the most part undefined, and were variously located by different observers. It was not until 1879 that, by simultaneous observations on either side of the St. John River, in Carleton county, made by Mr. G. F. Matthew and the author, something like satisfactory data upon these points were obtained; the unconformity of the Silurian system with the associated rocks, more particularly along the Beccaguimic valley, being then established upon the triple evidence of the composition of the conglomerates at the base of the former, the discordance of dip between the two, accompanied by progressive overlap, and finally of fossils, the lower rocks being found to hold a fauna apparently indicative of the age of the Trenton. In the same valley, at its mouth, a series of coarse conglomerates had been previously found by Mr. Chas. Robb to contain thin seams of shale abounding in remains of Psilophyta, and, upon the evidence of these, the beds containing them, together with a somewhat extensive tract of other coarse sediments occurring about the headwaters of the Beccaguimic, were referred (by Mr. R. W. Ells) to the Devonian, and regarded as the equivalents of the Gaspé sandstones.

A contact of the Silurian with at least two other systems was thus indicated in the Beccaguimic valley. But as it was difficult, from the limited exposures of a single narrow stream, the strata of which are, for the most part, excessively disturbed, to remove all obscurity as to their true relations, the author was led, during the last summer, to visit

some of the other localities which have been referred to above, more particularly those of Square Lake and Temiscouata, with the hope that some additional light might be thrown upon these points. The results of the comparisons thus made seem to him to be of sufficient interest to justify their presentation here.

In order to understand these comparisons, some further reference is necessary to the Beccaguimic region. Briefly stated, the conditions here seen are about as follows. In the bed of the North Branch stream, just above Shaw's Mills, are a few exposures of dark grey siliceous slates, having a nearly vertical dip, which are here and there capped by brownish red conglomerates, in a nearly horizontal position, and through which ridges of the slate project irregularly. From observations elsewhere made in the vicinity it seems certain that the bulk of these conglomerates are of Lower Carboniferous age, though some, which are harder and of somewhat different aspect, appear to be older, and may be Silurian. A little higher up siliceous slates again appear, but these now contain calcareous bands, from which, in 1879, Mr. Matthew succeeded in obtaining a number of small shells, chiefly of a species of Leptæna (allied to *L. decipiens* of Billings), as well as others apparently of the genera *Lingulella*, *Strophomena* and *Discina*, to which later collections, made by myself, Mr. W. McInnes and Mr. W. T. Reed, have added several, though fragmentary, specimens of the trilobite genus *Harpes*. There can be but little question that these beds are of Cambro-Silurian age, either Trenton or lower, and they tend to confirm the view so long entertained that this is the real age of a part at least of the great bands of slates and quartzites which constitute so marked a feature in the geology of this part of New Brunswick.

Passing now to the hills which, at a distance of a few rods only to the north, overlook the valley at this point, we meet with strata of a widely different character. Among these is a band of grey conglomerates and grits, in which are contained numerous fragments of black siliceous slate and quartzite, apparently identical with that of the beds in the valley below, cemented by a calcareous paste, in which, as observed by Mr. Matthew, are contained numerous encrinal fragments. These conglomerates, which at a short distance to the north are followed by heavy beds of limestone, are regarded as the base of the Silurian system, and, with the associated limestones, containing numerous fossils, have been traced for considerable distances through the adjacent country. A ridge of these conglomerates crosses the North Branch valley three miles above Shaw's Mills (their high inclination being again strongly contrasted with that of the red Lower Carboniferous conglomerates near by), but between these points are other beds which give further interest to the exposures of this vicinity. These consist of a series of sandstones and slates, of which the former are often grey, purple or chocolate-brown in colour and in aspect not at all unlike some portions of the Lower Carboniferous formation, while the slates are dark-grey and black. Both are fossiliferous, but in the sandstones the fossils are few, consisting of scattered relics of Crinoids, Orthocerata, and Brachiopods, mostly fragmentary, while the shales on the other hand, at least in certain layers, abound in the remains of Graptolites. These were at first believed by Mr. Matthew to contain diprionidial forms, but, in larger collections subsequently made, none of the latter could be detected, while a further study of the adjacent district confirmed the idea that both the slates and sandstones were of the same age as the gray conglomerates, and all Silurian.

It only remains to state, with further reference to this region, that here and there

through these Silurian sandstones may be found the remains of branching plants, while at one point, in close proximity to the siliceous beds first described, is a small exposure of quartzose rock containing an abundance of what are evidently Psilophyta, apparently undistinguishable from those found by Mr. Robb near the mouth of the river. As the conglomerates in which the latter occur are not unlike those described above as forming part of the Silurian succession, and as the plant-bearing beds above Shaw's Mills are almost certainly of this age, it is at least possible that all these rocks are really Silurian rather than Devonian, as some of them have been supposed to be.

I now pass to the region of the Fish River lakes in Northern Maine.

The description of the rocks found in this vicinity, as given in Hitchcock's "Report on the Geology of Maine" (1861, pp. 420-424) is from the pen of Prof. A. S. Packard, jun., who, however, does not himself express any opinion as to their age. Among these rocks the most interesting is a band of highly fossiliferous limestone, outcropping on the western shore of Square or Sedgewick Lake, and which has to some extent been locally employed as a source of lime. From collections made at the locality by Packard and Hitchcock, the late Mr. Billings succeeded in recognizing about forty distinct species, of which fourteen were new, while my own visit to the locality, though short, enabled me to obtain a somewhat greater number, including, as determined by Mr. Ami, two additional species not hitherto described. These fossils have been regarded, both by Mr. Billings and Mr. Ami, as being of Lower Helderberg age, and the enclosing beds, in this as in other respects, may be regarded as the counterpart of the limestone beds of the Beccaguimic region, in New Brunswick. Associated with these beds on Square and Eagle Lakes, and apparently enclosing them, there are, as described by Packard, ledges of red shale and conglomerate, with beds of grit, the conglomerates containing fragments of dark slate and jasper, and dipping 45° to the northward, in which direction they are followed, first, by buff-weathering fossiliferous sandstones and then by dark clay-slates, which, with other slates and sandstones, occupy the remainder of the country northward and eastward to the St. John River valley. A like succession was observed on the thoroughfare from Portage Lake, a few miles west of Eagle Lake, and at Ashland. All the rocks of the above section have been regarded by Prof. Hitchcock as Devonian, and are so represented in his map of Northern Maine, as they are in that accompanying the last edition of Sir Wm. Dawson's "Acadian Geology." If however the above relations are as supposed, it would seem altogether probable that the great bulk of strata here met with is, as on the Beccaguimic, of Silurian rather than Devonian age. I may add, from personal examination, that in almost every particular the beds of the Fish River lakes bear the closest resemblance to the beds which accompany and enclose the limestones of the Beccaguimic valley.

It is true that no graptolite-bearing beds were here observed, but beds of very similar character occur, while even on the Beccaguimic these beds are but thin. Moreover, in both instances the sandstones exhibit the same peculiar Lower Carboniferous aspect. Both contain similar remains of crinoids and shells, mingled with stems of plants, while the conglomerates in both are also alike in containing numerous fragments of black slate associated with others of bright green and red jasper. If to this we add the fact that, beneath the conglomerates, etc., above described, we have, on the shores of Portage or Nadeau Lake, connected with the other or westerly branch of Fish River, a well defined

belt of dark green siliceous slate,[1] described by Packard under the name of hornstone, and containing massive beds of bright red cherty slate, with a nearly vertical dip, we appear again to have a repetition of the relations found on the Beccaguimic, these cherty slates being, as we believe, the equivalents of the flinty slates of Shaw's Mills and, like the latter, of Cambro-Silurian age. The following tabular view will serve to make this parallelism more evident :—

1.—Beccaguimic Section.

A. *Cambro-Silurian.*
Black calcareo-siliceous slates, with brachiopods and trilobites.

B. *Silurian.*
1. Grey calcareous conglomerates and grits, holding fragments of black siliceous slates and quartzite, jasper, etc., mingled with remains of crinoids.
2. Grey, reddish and brown sandstones and slates, associated with beds of fossiliferous limestone.
3. Grey conglomerates.
4. Grey, calcareous and buff-weathering sandstones, with stems of crinoids and shells.
5. Grey and dark grey slates, with graptolites and remains of plants.
6. Grey, bluish-weathering and calcareous slates.

2.—Fish River Section.

A. *Cambro-Silurian ?*
Dark cherty slates, with bands of jasper.

B. *Silurian.*
1. Grey calcareous conglomerates ? not observed.
2. Grey, reddish and brown sandstones and shales, associated with beds and containing enclosed masses of fossiliferous limestone.
3. Grey, calcareous conglomerate, with pebbles of dark flinty slate, jasper, etc.
4. Grey, calcareous and buff-weathering sandstones, with crinoids and shells.
5. Grey and dark grey slates, with remains of plants.
6. Grey, bluish-weathering, calcareous slates.

I pass now, thirdly, to the Temiscouata region. Between the latter and the region of the Beccaguimic in Carleton county, the St. John River affords an admirable section of the Silurian system, without, however, exposing any beds which can with certainty be regarded as representing its base. For nearly the whole distance of one hundred and fifty miles, including the Madawaska River and the southern half of Lake Temiscouata, the only rocks seen are slates with occasional alternating beds of fine sandstone, mostly of grey or dark grey colours, but occasionally red or green, the beds of this latter colour being usually associated with beds of impure hematite. They are very generally calcareous, and at times highly so, but no actual beds of limestone occur. They are also at many points fossiliferous, the fossils including species similar to those of the Beccaguimic, and, like the latter, appearing to indicate an Upper Helderberg horizon. Finally, they have been subject to extensive disturbance, the plications being general and of the most complicated character.

The first beds of a markedly different aspect from the above are met with upon the

[1] These beds bear some resemblance to the beds of Pointe aux Trembles or Temiscouata Lake, to be presently described; and their true position, in both instances, is somewhat uncertain.

Tuladie River, not far from its mouth, and again on the shore of Lake Temiscouata, at a point nearly opposite the Tuladie, where they are alluded to in the elaborate section of this vicinity, given by Sir W. E. Logan, as "the beds of Pointe aux Trembles." These rocks are massive sandstones, of somewhat dioritic aspect and with bands of purple jasper, which pass into and include beds of conglomerate, the pebbles and matrix of which are both composed of dark grey or purplish-grey porphyritic petrosilex, mingled at times with fragments of black slate. Above these beds on the shores of the lake, but stratigraphically beneath them, the rocks next seen are shales and slates, alternating with sandstones, in which we have lately obtained fragments of ribbed shells. Similar beds are well exposed at the Tuladie Falls, and like the Silurian slates on the shores of the lake, have a pretty uniform south-easterly dip of 70°. The next beds north are those of Black and Burnt Points (*vide* Logan's section), and are again composed of conglomerates and sandstones, but with the former now greatly predominating and having quite a different aspect from those of Pointe aux Trembles, being not only very coarse, but of different composition, the pebbles consisting largely of metamorphic rocks, such as quartzite, white sandstone, mica schist, etc., mingled with many of limestone. These beds have also a south-eastward dip of 50-60°, and a measured thickness of nearly 1000 feet. They are further described by Logan as probably belonging to the Quebec group, and as being unconformably covered by the limestones of Mount Wissick next to be noticed.

An interval of about 1500 yards separates Burnt Point from the eminence last named, on whose almost precipitous north-western face (attaining an elevation of 550 feet) a most remarkable and interesting section of the rocks composing it may be seen. The order of succession and the thickness of the beds, as condensed from Logan's Report, is as follows:—

	Feet
Whitish massive sandstone	45
Grey coarse calcareous conglomerate, with pebbles of limestone and quartz.	20
Measures concealed	90
Green sandstone, with conglomerate bands, as above	20
Red and green shales, with included fossiliferous limestone	125
Grey nodular limestone, abounding in fossils	50
Grey hard sandstone, without observed fossils	10
Grey fossiliferous and columnar limestone	20
Grey arenaceous limestones and sandstones, with fossils, forming the bulk of Mount Wissick, and from the height of the latter estimated as having a thickness of	500

The dip of the above strata is given as S. 50, E. $< 13°$, and it is from this low dip chiefly, as compared with the high inclination of the beds north and south of the mountain, that they are regarded as unconformable to the latter, and as being a part of the Gaspé limestone series. The strata north of the mountain are grey calcareous sandstones and arenaceous limestones, with dark-banded green slates, highly inclined and greatly contorted, which are regarded as belonging to the base of the Quebec group, although originally classed and mapped as Devonian.

Reviewing the above, it would appear that, in the view of Logan, the line of separation between the Silurian system (Gaspé limestones) and that of the Quebec group is to be found at or near Pointe aux Trembles, all the strata north of the latter, except those of

Mount Wissick, and including the heavy conglomerates of Black and Burnt Points and the rocks of the Tuladie and Cabano, being referable to that group, while those to the south, together with those of Mount Wissick, are to be referred to the Gaspé Limestone series or Silurian. It is, however, to be observed that Sir William himself seems to have been in doubt upon this point, for while on one page (423) he describes the conglomerates of Black Point as belonging to the Quebec group, he subsequently refers to them (page 427) as being newer than the latter. On the other hand, the very striking resemblances which portions of these beds bear to those of the Beccaguimic and the Fish River lakes can hardly fail to attract attention. Thus the conglomerates of Black Point, though vastly thicker and coarser than anything seen in New Brunswick or Maine, apparently occupy the same position as those described on the southern side of the great Silurian plateau. They are, indeed, compared by Logan with a certain band of conglomerates met with near the mouth of the Siegas, fifty or more miles to the south, in the Silurian tract, a comparison which further indicates the uncertainty of opinion in which they were held by him. Again, both the green and red shales and fossiliferous limestones of Mount Wissick, though as regards the latter of much greater thickness, occupy the same relative position and bear much resemblance, both in aspect and in their fossils, to those of Fish River and the Beccaguimic. These fossils include large corals (*Favosites*) Brachiopods (*Strophomena*, *Leptæna*, *Pentamerus*, etc.), besides several species of Trilobites, and are probably of Lower Helderberg age, but until they have been accurately determined this comparison is uncertain. The most remarkable difference in the Mount Wissick beds, as compared either with those of the Beccaguimic River or the Fish River lakes, is that afforded by the massive white sandstones or quartzites which form the apparent base of the eminence referred to. No such rocks are to be met with anywhere over the extensive Silurian tracts of Northern Maine or New Brunswick. They do, however, bear much resemblance to the beds of like composition seen at frequent intervals along the Portage road between Temiscouata and Riviére du Loup, and again along the line of the Intercolonial Railway between the Metapedia River and Rimouski. The greater part of these, however, belong to the Quebec group, while those of Mount Wissick are interstratified with the fossiliferous limestones of the mountain, and are unquestionably part of the same formation. I am also informed by Mr. R. W. Ells that similar sandstones were found by Mr. Richardson to contain remains of *Pentamerus oblongus*. As the beds underlying them at Mount Wissick are almost entirely of the Quebec group, these quartzites would appear to form here the lowest member of the Silurian system, which would also appear to include all the beds of Lake Temiscouata south of this point—among them the conglomerates of Black and Burnt Points and the rocks of Pointe aux Trembles previously referred to the Cambro-Silurian.

The Temiscouata section, as compared with those of northern Maine and New Brunswick, previously quoted, would thus stand as given on the succeeding page.

I may add that, since reading the above paper, further examinations of the region about Lake Temiscouata, as well as of portions of Aroostook county, Maine, have been made, and numerous fossils obtained from Pointe aux Trembles, Tuladie Lake and elsewhere. These are now in the hands of Mr. Whiteaves, and the results of their examination will appear in the reports of the Geological Survey.

Ascending Section of Silurian Rocks.

Lake Temiscouata.

A. *Cambro-Silurian.* (Quebec Group.)

Greenish, reddish and black slates, banded with thin layers of dolomitic limestone.

B. *Silurian.*

	Feet.
Whitish sandstones	200
Calcareous conglomerates and sandstones, with limestone pebbles	130
Red and green shales, including fossiliferous limestones	125
Grey nodular limestones, abounding with fossils, and including bands of hard sandstone	580
Measures concealed	1276
Conglomerates (of Black and Burnt Points), with pebbles of Cambro-Silurian rocks, including limestones	1000
Measures concealed.	
Dark shales and sandstones, with fossils.	
Green and purplish sandstones and conglomerates, forming Pointe aux Trembles.	
Grey-bluish weathering slates and sandstones, continuous with those of Maine and New Brunswick.	

V.— *Note sur le contact des formations paléozoïques et archéennes de la province de Québec.* *Par* L'ABBÉ J. C. LAFLAMME.

(Lu le 28 mai 1886.)

Quiconque étudie la stratigraphie des formations archéennes et paléozoïques de la province de Québec est frappé des grandes lacunes qui se rencontrent fréquemment dans la série des divisions qui en composent l'ensemble.

Pour expliquer ces lacunes, sir W. Logan, dans la *Géologie du Canada* de 1863, suppose une suite de mouvements d'affaissement et d'exhaussement qui auraient affecté cette partie du continent américain du Nord, et qui auraient ainsi permis à l'océan silurien d'envahir à diverses reprises une partie plus ou moins grande du noyau continental émergé dès le commencement des âges géologiques. D'après lui, les grès de Potsdam se seraient déposés dans un océan très profond, sauf de petits lambeaux éparpillés sur les rivages. Les lits du groupe de Québec auraient pu s'accumuler dans une mer moins profonde, mais dont le bassin devait s'enfoncer lentement pour permettre l'accumulation de ces sédiments si puissants. Tellement qu'à la fin, l'océan aurait envahi de nouvelles surfaces continentales, et les premiers lits du calcaire de Trenton se trouvaient ainsi à reposer directement sur les formations archéennes, sans aucunes traces de formations cambriennes ou précambriennes.

Ayant été à même, depuis plusieurs années, d'examiner avec soin et en détail le contact du calcaire de Trenton et des gneiss archéens, je prendrai la liberté de vous communiquer quelques remarques qui seront peut-être de nature à mieux faire saisir les conditions spéciales dans lesquelles ces calcaires siluriens se sont déposés directement sur les formations archéennes, soit gneissiques, soit labradoritiques.

Vu l'énorme espace de temps qui s'est écoulé entre l'émergence du noyau archéen et les dépôts calcaires, on peut se demander s'il ne serait pas possible d'y trouver quelques faits capables de donner une idée de l'érosion qu'avaient subie les surfaces calcaires avant d'être recouvertes par les assises calcaires.

C'est au Saguenay, sur les rivages du lac Saint-Jean, que j'ai observé les phénomènes les plus remarquables ayant trait à ce point en particulier. A plusieurs reprises, j'ai pu constater, soit un véritable lac calcaire entouré de tous les côtés par des rivages laurentiens, soit des collines de gneiss perçant de leurs sommets arrondis les assises calcaires gisant horizontalement à leur base. La hauteur de ces collines dépassait quelquefois d'une cinquantaine de pieds les lits calcaires supérieurs. Tel est le cas en particulier pour une élevation placée au nord-ouest du village de Roberval. Ailleurs les ondulations de la surface gneissique inférieure étaient presque insensibles. Et c'est à peine si les rides archéennes perçaient les quelques pouces du calcaire déposé sur leur surface.

En voilà assez pour nous faire voir que la surface du noyau archéen avait déjà été passablement modifiée par l'érosion, au moment où l'océan silurien l'envahit pour le recouvrir de lits calcaires. D'ailleurs, là où ces derniers ne sont pas très épais, on peut,

dans une certaine mesure, suivre les grandes ondulations du gneiss sous jacent, en notant les ondulations du calcaire lui-même. C'est là un fait remarquable que j'ai constaté partout où j'ai trouvé les lits de Trenton reposant directement sur le laurentien, pourvu que leur position originelle n'eût pas été modifiée par des bouleversements subséquents. Sur les bords du lac Saint-Jean en particulier, on rencontre plusieurs rochers laurentiens qui s'avancent dans le lac, et qui sont recouverts par des lits calcaires disposés en une espèce de bonnet arrondi, la stratification concordant absolument avec le plan de la surface gneissique. De plus, sur les bords du lac comme sur la côte de Beaupré, les lits de Trenton inclinent toujours dans le même sens et sous le même angle que l'ensemble de la surface laurentienne sur laquelle ils reposent. Cependant, quand l'épaisseur des lits calcaires est considérable, ce parallélisme disparaît.

Ceci indique que les lits inférieurs d'une formation se moulent plus ou moins sur la surface qui leur sert de support, et qu'ils ne se déposent pas rigoureusement suivant un plan horizontal, comme l'indiquent bon nombre de manuels de géologie.

Je me permettrai d'attirer particulièrement votre attention sur un fait qui m'a toujours frappé dans l'examen des nombreux contacts géologiques que j'ai eu à faire. C'est d'un côté la netteté de la surface laurentienne, l'absence de toute trace de décomposition dans les gneiss, les syénites ou les granites, et de l'autre la continuité presque mathématique des mêmes surfaces, que vous les examiniez dans les parties dénudées ou dans les endroits encore recouverts de calcaire.

Tout le monde sait que nos roches laurentiennes cèdent en général assez facilement aux actions atmosphériques. Les minéraux qui les constituent se décomposent à la longue, et les surfaces exposées à l'air et à l'action des plantes sont bien vite altérées. Evidemment, durant les longues années qui se sont écoulées entre l'émergence du continent archéen et les dépôts siluriens, la surface des roches exposées à l'air a dû être profondément altérée. De cette altération ont certainement résulté des débris minéraux en grande quantité. Comment se fait-il alors que ces surfaces, une fois ensevelies sous les eaux aient été si bien lavées qu'il ne reste plus aucune trace de leur altération antécédente ? Comment se fait-il que les détritus aient complètement disparu, de manière que la transition d'une formation à l'autre soit toujours aussi tranchée qu'on le remarque, et que les lits calcaires inférieurs ne renferment presque jamais de fragments des assises sur lesquelles elles reposent ? Je sais qu'on a mentionné l'existence de galets laurentiens dans quelques-uns de ces lits calcaires. Mais, au lac Saint-Jean, là où l'on peut si facilement étudier les phénomènes de contact, je n'en ai jamais vu.

Faut-il attribuer ce curieux état de choses à l'existence de grands courants qui, au moment de l'envahissement des continents, auraient balayé, nettoyé les surfaces envahies, et transporté au loin les débris qu'ils leur arrachaient ? La chose n'est pas impossible. Cependant ces courants sont quelquefois difficiles à supposer, par exemple, dans le bassin si restreint et si bien fermé du lac Saint-Jean.

Dans un autre ordre de faits, la continuité presque absolue d'une même surface laurentienne, dans les parties dénudées et dans les parties recouvertes de calcaire, porte à conclure que l'érosion du glacier quaternaire sur les roches archéennes n'a peut-être pas été aussi considérable qu'on est exposé à le croire au premier abord. Le glacier aurait plutôt régularisé et poli la surface des roches que modifié profondément les grandes lignes des reliefs continentaux.

Le contact du calcaire et des schistes immédiatement supérieurs, — contact qu'il est facile de constater en maints endroits, et au Saguenay et aux environs de Québec, — est lui-même très intéressant. Le passage du calcaire compact à une argilite bien caractérisée est très brusque. Pas de traces de transition d'aucune sorte. Le premier lit argiliteux, le plus inférieur, est en règle générale d'un noir assez foncé, et grouillant à peu près exclusivement de graptolites ; ce qui indique un changement subit dans l'océan silurien, et une apparition également subite d'un faune d'un type tout à fait différent.

Ces schistes gardent partout leur caractère bitumineux. Quelquefois même ils peuvent servir de combustible. A l'île de la Traverse, au lac Saint-Jean, île qui n'est tout entière qu'un amas de ces schistes plus ou moins effrités, le feu prit un jour dans les graviers bitumineux du rivage et brûla pendant dix-huit mois. Il ne fut éteint que par une hausse extraordinaire du lac. Dans les mêmes schistes se trouvent encore des sources minérales, partout où ils n'ont été soumis qu'à peu de bouleversements.

Je ne puis quitter cette région du Saguenay, si intéressante par le développement du silurien inférieur, sans signaler un troisième bassin silurien qui n'est pas encore indiqué sur les cartes géographiques. Le rapport de 1863 mentionne le gisement calcaire du lac Saint-Jean. Dans le premier volume des travaux de la Société Royale, j'ai indiqué l'existence d'un second bassin silurien situé au nord-est du Saguenay, et dont j'ai été chargé plus tard de faire le relevé. Je suis heureux de compléter aujourd'hui ces renseignements en affirmant l'existence d'un troisième dépôt de calcaire silurien placé à peu près dans l'angle formé par la baie des Ha ! Ha ! et la rivière Saguenay. La carte détaillée n'en a pas encore été faite. Cependant tout laisse croire que le calcaire est, là aussi, recouvert des argilites d'Utica, bien que je n'aie pu encore le constater *de visu*. La présence de sources minérales en cet endroit est pour moi un indice très probable de ce fait.

Je n'ai jamais pu voir les argilites d'Utica reposer directement sur le laurentien, si ce n'est dans les nombreuses failles de la côte de Beaupré. Or, comme ces argilites ont recouvert partout le Trenton, elles ont dû nécessairement se déposer sur les rivages gneissiques de l'océan à la fin de l'époque Trenton, et leur absence actuelle des surfaces laurentiennes doit être sans doute attribuée à l'action du glacier quaternaire qui a balayé du premier coup ces roches légères et friables.

Les remarques que je viens de faire sur les contacts du laurentien et du Trenton, dans la région du Saguenay, s'appliquent également aux mêmes phénomènes tels qu'on les voit sur la côte de Beaupré. Ici encore on trouve le calcaire reposant directement et à peu près horizontalement sur le gneiss, sans aucune trace de transition d'une formation à l'autre. La surface des assises laurentiennes est parfaitement nette, et, comme au Saguenay, ne présente pas la plus légère trace de décomposition.

Cependant j'ai observé sur les bords du Montmorency, là où l'on peut suivre ces contacts sur l'espace de plusieurs arpents, une particularité que je crois digne d'être signalée. C'est l'existence, dans la surface gneissique sur laquelle repose le calcaire, de cavités circulaires, étroites et profondes, toutes remplies d'un calcaire fossilifère absolument semblable aux lits immédiatement superposés. L'apparence de ces cavités est tellement caractéristique, qu'à première vue, on les rapporte naturellement à ces chaudières ou marmites de géants creusées par les rivières dans les assises sur lesquelles elles coulent. Et je crois réellement qu'elles ont une origine analogue, qu'elles sont de véritables chaudières creusées par les rivières archéennes, se déchargeant dans l'océan archéen ou silurien. Qui

sait si on ne trouverait même pas au fond de ces cavités, empâtées dans une gangue calcaire, les galets qui ont servi à les creuser. Ces cavités sont en général peu profondes. Elles ne dépassent guère cinq ou six pouces. Plusieurs ont à peine trois pouces.

Sur ces mêmes rivages siluriens on trouve des amas de sable très remarquables qui sont intercalés entre le laurentien et le Trenton. Sir W. Logan rapporte ces lits sableux à la formation de Potsdam. Il me semble plus simple et plus naturel de les regarder comme des dépôts accidentels sur les rivages de l'océan trentonien. En effet on s'explique difficilement la persistance de ces minces assises friables, durant les longues années qui se sont écoulées entre le Potsdam et le Trenton. Exposés à l'air ou cachés sous les eaux, on conçoit difficilement qu'ils auraient résisté aux nombreux agents tendant à les enlever.

Vous trouverez ces sables accumulés dans les cavités superficielles du laurentien, lités avec une merveilleuse régularité et absolument privés de fossiles. Leur stratification n'est pas rigoureusement concordante avec celle du Trenton.

Cette dernière formation est bien plus puissante sur la côte de Beaupré qu'elle ne l'est nulle part au Saguenay. A ce dernier endroit, je n'ai jamais constaté qu'elle dépassât 200 pieds d'épaisseur. Tandis que sur la rivière Larose elle dépasse certainement 500 pieds. Là, on peut en voir et la base reposant sur le laurentien et le sommet recouvert des lits d'Utica ; et, comme les lits n'ont pas été bouleversés, la section générale peut en être faite d'une manière assez précise.

Au reste les caractères minéralogiques généraux sont les mêmes qu'au Saguenay. Il n'y a que l'épaisseur qui soit plus grande. C'est toujours le même amas de lits calcaires, régulièrement superposés et rarement séparés les uns des autres par de minces feuillets schisteux. Aucune assise ne tranche nettement sur ses voisines, et l'ensemble de la formation est, comme au Saguenay, d'une homogénéité frappante.

Aussi me paraît-il tout à fait impossible de placer dans la formation trentonnienne, telle qu'ellle est désignée jusqu'à présent, le massif du rocher de Québec, comme quelques-uns semblent le vouloir.

En constatant la persistance du caractère minéralogique général de cette formation, dans deux régions aussi distantes l'une de l'autre que le Saguenay et la côte de Beaupré, il est difficile de concevoir que ce caractère se modifie si rapidement, et surtout si complètement, dans l'espace qui sépare la côte de Beaupré de Québec, quelques milles à peine. D'autant plus que ce ne serait là qu'une modification purement locale, qui ne se rencontrerait nulle part ailleurs. Le rocher de Québec renferme des masses de lits dolomitiques, des schistes rouges et bruns, des conglomérats de toute nature, que vous chercheriez vainement à n'importe quel endroit des assises de Trenton.

Evidemment il n'y aurait que des découvertes paléontologiques absolument indiscutables qui pourraient prouver cette thèse. Existent-elles ? Ont-elles bien du moins la portée qu'il faudrait leur attribuer ? Nous ne sommes pas en mesure de répondre d'une manière compétente à cette double question.

Si vraiment les fossiles découverts dernièrement dans le rocher de Québec rendaient impossible son classement dans le groupe dit de Québec, il me semble que la place qu'on pourrait lui assigner devrait être intermédiaire entre le groupe de Québec proprement dit et le Trenton, au-dessus du premier et au-dessous du dernier. Si je ne me trompe, cette idée est de nature à résoudre une partie des nombreuses difficultés qu'a toujours présentées le classement définitif des différentes sections de ce groupe.

Ces roches inférieures au Trenton auraient été amenées à la surface par le renversement des lits, le long de la grande ligne de rupture qui traverse en diagonale la province de Québec. Cette hypothèse ferait éviter du coup la nécessité de croire à ces failles à courbures étranges et compliquées, qu'il faut supposer pour arriver à placer ces lits dans la formation de Trenton.

Toutefois il faut admettre que des failles existent près de la ligne de cette énorme rupture dont nous parlions plus haut, mais elles ont une disposition très simple et une direction très régulière. Il est facile de le constater en particulier sur tout le parcours de la côte de Beaupré. On rencontre, depuis le cap Tourmente jusqu'à Montmorency, trois de ces failles secondaires, ou mieux de ces lézardes accidentelles, causées par la cassure gigantesque qui court sur la côte nord de l'île d'Orléans. Elles sont toutes rectilignes ou à peu près, et coupent obliquement le rivage du fleuve. Leur effet stratigraphique est d'amener, à diverses reprises, le Trenton et même l'Utica à buter sur un escarpement laurentien sous un angle très fort. De plus les différents affluents du Saint-Laurent qui arrosent cette partie du pays ont tous une chute plus ou moins haute, qui est toujours causée par l'intersection de l'une de ces failles. La lèvre sud, constituée par les lits moins résistants de l'Utica et du Trenton, a disparu plus vite que la lèvre nord, et la chute s'est ainsi produite.

Il est bien probable que le grand renversement dont nous parlions plus haut a produit encore d'autres ruptures secondaires, le long de la ligne d'escarpement que Logan supposait dans la mer silurienne, ligne dont la direction est donnée approximativement par le tracé de ce renversement lui-même. La petite faille qui coupe le rivage à la Pointe-aux-Trembles, et qui fait buter sous un angle très fort les argillites d'Utica sur les lits horizontaux de Trenton et sur le gneiss, n'a vraisemblablement pas d'autre origine.

Voilà en peu de mots les quelques réflexions qui me sont venues à l'esprit durant les études stratigraphiques assez détaillées que j'ai été obligé de faire dans cette partie du pays. Sans doute il n'y a en tout cela aucun fait saillant qui se détache avec éclat et qui puisse servir de point de départ à des théories complètement neuves. Mais j'ai cru que la géologie de notre pays, à peu près terminée dans ces grandes lignes, du moins dans les anciennes provinces du Dominion, profiterait un tant soit peu de recherches plus détaillées, plus minutieuses, faites en différents endroits. Il m'a semblé que ces travaux restreints étaient précisément destinés à contribuer, au moins pour une petite part, à remplir le cadre de notre géologie canadienne, si magistralement tracée depuis de longues années déjà par notre commission géologique.

VI.—*Mechanism of Movement in Cucurbita, Vitis and Robinia.*

By D. P. PENHALLOW, B. Sc.

(Read May 27, 1886.)

The valuable contributions of Darwin[1] to our knowledge of the movements of plants, about ten years since, led to an examination of this most interesting question, and eventually, to the particular form of it to be discussed in the present paper. At that time, the idea of the individuality of the cell prevailed, although Sachs had already demonstrated the continuity of protoplasm through the sieve plates of Cucurbita[2] and had formulated an expression in which he indicated a strong belief in the continuity of all living cells. It is only within very recent years, however, that sufficient reason has been given for a general change of opinion on this question. The additional light which has of late been thrown upon our knowledge of the cell, in its mutual relations, has presented many new and important subjects for consideration with reference to the physiology of movement in plants.

In the motile organs of plants—as represented by those now under consideration—we have to deal with organs which on the one hand are modified as a whole, with reference to their external form, and are thus adapted to a particular purpose, as in Cucurbita and Vitis; or which, on the other hand, show these modifications to be strictly localized, as in the pulvinus of Robinia. In each case, moreover, the internal structure is usually modified in an important way, and to a striking degree. In the tendrils of Cucurbita and Vitis, this occurs in the excessive thickening of the hypodermal tissue, which becomes almost entirely collenchymatous; in the localized development of active fundamental tissue lying in the outer hypodermis; and in the excessive formation of some vascular element—usually bast—which thereby produces a more or less continuous zone or vascular cylinder, internal to the softer parts of more active growth. In the pulvinus of the Robinia, the modification is chiefly found in the excessive hypertrophy of the hypodermal tissues, either at the base of the petiole, or throughout the entire length of the petiolule. In all of these cases, the true relative positions of the tissues, as found in the unmodified organ, e. g. stem or petiole, are fully maintained, but the special change developed in each of the component tissues causes an unusual relation to be established between them, so far as their mutual tension is concerned. This at once introduces an important factor in the conditions of equilibrium which would otherwise be maintained, with the result that some disturbance of this condition must sooner or later occur, and this disturbance then becomes outwardly manifest in the form of motion.

Since variations of this character can occur in living tissues only, they must be

[1] Journal Linnean Soc., Vol. ix, 1865.

[2] Text-book, p. 89.

referred primarily and in general terms to conditions of growth, of which they are the result. They may arise, however, as already pointed out,[1] either from unequal growth and nutrition of parts, or from special conditions of turgescence, one or both combined. Or, as Sachs[2] states, "in those movements which occur during growth, the tension of the tissues is concerned only so far as any change in it reacts on growth and modifies it. Periodic movements, and those due to irritation, on the contrary, depend entirely on changes in the the tension of the tissues, which, in this case, are fully developed only when the organ has attained maturity."

These general principles apply to all the subjects now under consideration, and accepting them as tenable, we shall not in the present paper concern ourselves more particularly as to the special physiological changes involved, and whatever references are made to growth are to be accepted in the general meaning of that term, unless otherwise specified. Two general considerations are of importance in this connection, viz., the mechanical value of the tissues, and the continuity of protoplasm.

Of the various tissues which enter into the composition of motile organs, parenchyma, collenchyma, bast and wood, are of chief value. Of these, the parenchyma probably stands first as capable of the most rapid growth and the most extreme variations of tension from turgescence or other cause. The collenchyma undoubtedly stands next in both of these respects; while the bast, from its more permanent character, as well as from the results obtained by both Schwendener[3] and Haberlandt,[4] in which the great elasticity of this tissue appears, is in all probability the most important mechanical element, by reason of the retarding influence it exerts upon the growth of the more rapidly extending and external parts.

The inference which naturally follows from this is, that the principal conditions of tension with reference to elongation, are established and maintained primarily between the parenchyma and collenchyma on the one hand, and the bast and other vascular elements on the other; and secondarily, between the parenchyma and the collenchyma. It will also follow that, whenever one of these last-named tissues is in excess, it must exert a preponderating influence in changes of tension, without special reference to its particular capacity for such variations.

One of the most important factors in the physiology of motion, particularly that due to irritation, is the continuity of protoplasm. This fact has now been observed in so many widely different cases, and involves so little difficulty in its determination in almost any living tissue, that we can no longer regard its application as a general law, with reasonable doubt[5]. This law is of so recent origin, however, that at present but little is known as to its precise relation to motion; but that it is connected with it in those cases where there is distinct transmission of impulse to parts somewhat remote from the centre of

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[1] Darwin, Movements of Plants, p. 2. Sachs, Vorlesungen über Pflanzen-Phys. p. 775.

[2] Text-book, 2nd Ed. p. 878, etc. Morren, La Sensibilité et la Motilité des Veg. Bruxelles, 1885, p. 52, etc.

[3] Das Mechanische Princip. im Anatomischen Bau der Monocotylen. Leipsig, 1874.

[4] Physiologische Pflanzen Anatomie.

[5] Bot. Centralbl. xiv. 89—121. Proc. Royal Soc., xxxv. 163. *Ibid*, xxxiv. 272. Jahrb. Wiss. Bot., xii. 170. Vorlesungen über Pflanzen-Physiologie, Sachs., 102. Nature, xxx. 182. xxxi. 337, 290, 390. Quart. Jour. Mic. Sci., Oct. 1882. Phil. Trans. Royal Soc., 1883, 817. Flora, 1863, 68. Hanstein, Die Milchsaftgefässe, 1864. Wilhelm, Zur Kenntniss des Siebröhrengefässe Dicotyler. Pflanzen, 1880.

irritation, can hardly be doubted in the light of observed facts.[1] It remains to determine in what way these transmissions occur through the protoplasmic medium. At present, therefore, we must confine our considerations to continuity of protoplasm, in its structural relations to the tissues of the motile organs.

In both the grape and the squash, the continuity appears most prominently in the collenchyma tissue of the rather thick hypodermis. It may also be observed without difficulty in the active parenchyma of all parts external to the xylem portions of the vascular bundles. The same treatment, however, does not answer equally well for its detection in each case, owing to the different character of the tissues involved. In the pulvinus of Robinia, Gardiner[2] has already pointed out the clearly defined continuity which may be observed both in the parenchyma and in the bast. In the latter tissue we have found it to be most strikingly prominent, its exhibition being much less difficult than in the softer tissues, probably owing to the presence of numerous channels in the cell walls, which serve to localize and more sharply define the connecting filaments.

The method employed for the exhibition of continuity must depend upon the character of the particular tissue involved. Any one of these methods, all of which have been employed by Gardiner and others, may be used according to circumstances. The first we may distinguish as the salt method. For the purpose there should be prepared a 10 p. c. solution of common salt. This has been recommended by Gardiner[3] as giving the best results in most cases, an opinion fully confirmed by our own experience. Perfectly fresh and thin sections are immersed in a suitable quantity of the solution and allowed to lie until wanted for the final staining. The action of the salt is to contract the protoplasm gradually into a compact, rounded mass, towards the centre of the cell, and thereby preserve intact the original connecting filaments, which then become drawn out into long, slender threads. There is, however, no appreciable change in the cell wall. A distinct development of continuity will generally be formed within a period of ten minutes, but, for good results, at least half an hour should be given; and since, with continued action, the salt consolidates all the contracted parts and thus renders all the filaments more distinct, an immersion of the sections for twenty-four or thirty-six hours may often prove desirable. If the solution be stronger than 10 p. c., the action is too rapid and many of the more delicate filaments snap during development, so that we then observe only their contracted remains upon the cell wall, with corresponding processes from the main protoplasmic mass. Treatment of this description answers admirably for all unmodified parenchyma tissue, such as that in the squash fruit the flesh of the apple and pear, and in the pulvinus of the Robinia. It does not answer so well, however, in the case of thick-walled cells, whether collenchyma or bast. Then one of the following methods is to be preferred.

The second method may be distinguished as the sulphuric acid process[4]. Very thin sections, freshly cut—one or two at a time, according to size—are placed upon the end of a glass slide or platinum foil. Surplus moisture is now removed in order to secure uniform action of the acid. A drop of concentrated sulphuric acid is then placed on the slide

[1] Janczewski, Etudes Comparées sur la tubes Cribreux, 1881. Russow, Sitzberg. Dorpater Naturf. Ges., 1882, 23, 257—327. Tangl, Pring's Jahrb., xii. Strasburger, Bau und Wachsthum, 23.

[2] Proc. Royal Soc., xxxv. 163—166.

[3] *Ibid.*, xxiv. 272—274.

[4] Bot. Centralb., xiv. 89—121.

or foil, immediately above the sections, and allowed to flow down over them quickly. Very careful attention is now needed to control the action at the proper moment. In the course of three or four seconds the sections acquire a faint brownish color, which rapidly deepens as the dehydrating action of the acid proceeds. Its first appearance indicates, in most cases, that the action has been continued long enough. The slide is, therefore, quickly plunged in a dish of water which must be ready for that purpose, and the sections thoroughly washed. They are then ready for staining.

The action of the acid, dependent upon its dehydrating properties, is first to contract the protoplasm. It next causes the cell wall to swell strongly and partly dissolve, thus rendering it so transparent as to permit the threads of protoplasm which traverse it to be seen distinctly when stained. The swelling of the wall also tends to aid in the contraction of the protoplasm, while the channels become longer, and further aid in defining the filaments. If great care be not used in this process, the section will be quickly and wholly dissolved. This process is of special advantage as a quick method, while it gives most gratifying results, and it has been chiefly relied upon by us. It may be employed in ordinary parenchyma tissue, and also with great advantage in collenchyma and bast, to the treatment of which latter two, it is best adapted. This is one of the oldest of all the methods now in use.

The third method, and that which Gardiner seems to regard with the greatest favor is the chloriodide of zinc process. This admits of two variations; in the first, the sections are immersed for a short time in an ordinary aqueous preparation of iodine, until the characteristic reaction is developed. They are then transferred to the chloriodide, when they quickly turn dark brown, owing to the intensity of the iodine reaction. After about ten to thirty minutes in this latter reagent, they are washed out in distilled water until the brown color disappears. This method is said by Gardiner to have the special advantage of causing the protoplasm in all its parts, to take a much deeper stain when finally colored with aniline. The second variation simply omits the preliminary treatment with iodine. Preparations by this method, show the filaments very distinctly, and the walls of the cells so strongly swollen as to render them quite transparent. It may therefore be used instead of the last process by sulphuric acid.

Sections treated by any one of these methods, require subsequent staining, in order to differentiate the delicate filaments from the surrounding cell wall. The method originally employed by Tangl[1], in the case of endosperm cells, was to stain with iodine. Our present methods, however, permit of much more accurate results. The stain recommended by Gardiner[2] as used by us, gives most satisfactory results. It is prepared as follows:—To a 50 p. c. solution of alcohol, add picric acid to saturation. To this add aniline blue (we used BB with good results) until the residual color imparted to a section, is deep blue. To facilitate solution, one or two drops of acetic acid may be added to the stain with advantage. Sections previously treated and well washed, are immersed in the stain for a few moments and then washed out in fresh alcohol until the yellow is all discharged and the color of the section changes from green to clear blue. It will then be found that the picric acid, in passing out from the section, has withdrawn all the aniline from the cell walls, but that it has left it in the protoplasm, for which it has a special affinity. The colorless cell walls

[1] Pringh's, Jahrb., 1880, 170.

[2] Phil. Trans., clxxiv. 817.

and the colored filaments are thus brought into sharp contrast, and the latter may easily be recognized under a sufficiently high power. Sections so prepared may be placed in 25 p. c. glycerine for future examination. For permanent mounts, glycerine jelly should be used. Balsam will answer for exhibition of continuity in the bast tissue, and will even preserve it for several months in the softer tissues, but in the latter case, the protoplasmic filaments gradually break up, and ultimately disappear.

I.—Cucurbita maxima and pepo.

Histology.—The tendrils of the squash externally present the form of long, slender filaments, well rounded, but with a somewhat greater transverse than vertical diameter, and on the upper side flattened and slightly grooved for almost their entire length. The surface is generally smooth, though soft scattering hairs usually appear towards the upper side. The prevailing color is a very pale or whitish green, due to the deeply seated chlorophyll-bearing layer, which is internal to the collenchyma. This pale hue, however, is found to be interrupted along three lines, extending from base to tip of the tendril, in which the color is a strongly marked green, thus bringing these bands into strong prominence by contrast with the surrounding and lighter parts. These three lines or bands of tissue, always occupy the same positions, which are found to be, one on each side, just at the horizon of the major axis of transverse section, and the third in the position of the channel along the upper side of the arm, at the upper extremity of the minor axis. Aside from their more special value in circumnutation, these bands serve as most valuable means of noting certain changes incident to movement, e. g. those of torsion. The tip of the tendril is invariably turned slightly backward, or towards the lower side of the tendril arm, though during certain phases of the circumnutation, changes due to torsion often cause it to point upward.

Internally, the tendril presents several important features. Transverse sections disclose the form and relation of parts shown in Plate IV, Fig. 1. From this, the following details may be gathered :—

The epidermis consists of a single row of cells, which are either of the same size in both directions, or somewhat elongated in a direction perpendicular to the general surface. The epidermal hairs, so far as they may be present, are confined almost wholly to the upper and lateral surfaces at *b*, being absent from the surface below the horizon of the major axis *b'*. The hypodermal tissue consists of a rather thick layer of collenchyma (*b b'*), which is almost continuous throughout the entire circumference of the tendril, its continuity being interrupted in the three regions *a*, *a'*, and an opposite to *a'*. These areas of interruption correspond to the three green bands already referred to. The collenchyma itself is thus separated into three distinct bands, which traverse the tendril throughout its entire length, one being larger and inferior in position at *b'*, and two smaller and superior as at *b* and its corresponding part on the other side. The first is usually distinguished by being somewhat thicker, and also of much greater lateral extent than the other two combined. The detailed structure of this tissue is shown in Fig. 3, from which it appears that the collenchymatous thickening is somewhat general over the entire surface of each cell.

At the three points *a*, *a'*, *a''*, the continuity of the collenchyma is interrupted by groups of parenchyma tissue, which extend as longitudinal bands throughout the entire length of the arm. This tissue has certain important distinguishing characteristics. The cells are usually large, well rounded, and thin walled (Fig. 1, *a a'*, and Fig. 5). They contain an abundance of protoplasm and chlorophyll, and possess all the features of cells in an active condition of growth. Indeed, the activity of this tissue is conspicuous from the earliest period of circumnutation until long after the surrounding parts have become hard and woody, and all motion has ceased. Within the area of this tissue are to be found intercellular spaces (not shown, however, in the figure) together with their corresponding stomata, which latter are confined to the epidermis of these bands. The very large amount of chlorophyll here present, is the means of that outward distinction to which we have already referred. Inwardly, each of these groups of cells connects directly with the pith region of the tendril, thus causing a further break in the continuity of the interior tissues. From the very prominent part which this tissue evidently takes in the circumnutations of the tendril, and the frequency with which pointed reference must be made to it, we have deemed a descriptive term essential. We have, therefore, applied to it the name of "Vibrogen" or "Vibrogenic tissue," as signifying that the origin of the ordinary circumnutation is to be found there.

Immediately internal to the collenchyma is a zone of rather large, thin-walled parenchyma tissue, *c*, usually disposed in three or four rows, of which the innermost cells are the smallest. This tissue, which is essentially the mesophlœum of the stem, forms a continuous zone through each of the vibrogen bands. The cells are filled with protoplasm, and contain some granular matter and a small amount of chlorophyll, which imparts the subdued green color to the tendril as a whole. The tissue presents all the characteristics of active growth, but it in all probability is inferior in this respect to the energy of the vibrogen bands—as will appear later—though it undoubtedly contributes its part as a factor in the general circumnutation. Directly interior to this tissue is the bast zone of the liber. At a very early period in the growth of the tendril, the bast portions of the vascular bundles establish conjunctive growth, and thereby form a zone (*d*), the continuity of which is interrupted only at those three regions where the vibrogen establishes its connection with the pith. In its earlier period of growth, the bast cells are all thin walled (Fig. 2 A). They are then in a condition of active growth, and are capable of conforming to the general and rapid elongation of the organ as a whole. It is this condition which essentially characterizes these cells during the greater portion of the tendril's active period, but most conspicuously so during the earlier portions of it, since we find that, with the growth of the organ, the bast cells gradually increase in thickness and assume more and more completely their true character as permanent structure. And this becomes more conspicuous towards the end of the active period, when the motion of the tendril is gradually retarded, and becomes continually more spasmodic, until finally it ceases altogether. We then find that from thin-walled cells the bast has changed to thick-walled, permanent tissue, as shown in Fig. 2 B. This, then, defines the hard and woody character of the tendril, which is so conspicuous a feature after coiling.

It is important to point out in this connection that as soon as this woody character in the tendril is fully developed, all motion must cease; and since the lignification is a gradual process, and will be completed within a definite period—assuming constant

conditions of nutrition,—we must recognize the probability of a gradual modification in uniformity, as also of a gradual cessation of motion, and the impossibility of the activity being prolonged or even shortened; unless conditions of permanent contact and irritation are established, when maturity is accelerated. As will appear later, the motion resolves itself into an expression of the resultant of activity in two tissues, one of which is continually growing, while the other is as continually becoming less active, and the cessation of motion must then be determined when the latter gains complete ascendancy over the former, and thus permanently destroys the equilibrium of growth.

Internal to all the histological elements thus far discussed, lie the xylem portions of the vascular bundles. These, however, are widely separated. They are seven in number, the three largest traversing the lower region of the tendril arm. As elements of permanent structure, they must undoubtedly serve in a degree to supplement the mechanical value of the bast, but to this they are obviously very subordinate. Within the vascular zone is the somewhat large pith which, especially at the base of the tendril arm, early develops what De Bary[1] designates as a "lysigenetic intercellular cavity," to the extent that the organ becomes hollow for a considerable distance from its base. This also characterizes the petiole of both tendril and leaf, in each of which the same structural elements appear, and in much the same relative positions.

Of the elements thus considered, we must regard the vibrogen, collenchyma and bast as of primary importance, and that they bear a definite relation to the circumnutation of the tendril, and to its behaviour under the influence of irritation, can hardly be doubted in the light of the facts to be presented in the following pages.

Growth in Length.—In vigorous vines, the largest tendril arm often exceeds 30 cm. in length. The extreme lengths of the tendril arm, during the entire period of circumnutation, may generally be taken as ranging from 8 cm. to 35 cm. As this great elongation must occur within the very limited period of two days, it indicates a most rapid organizing process, as the following determinations will show. Moreover, it must be borne in mind that the cessation of growth in length and of circumnutation is simultaneous. The following determinations have been obtained. An arm just uncoiled from the bud measured 12 cm. in length. One day later it had increased to 14.8 cm., and on the following day to 18.3 cm., thus giving a total increase in length of 6.3 cm., or one-half the original. August 8th, five tendril arms, but a short time in action, were measured and marked. The Monday following (10th) all except one were found to have coiled about themselves or other objects. The coils were drawn out and measured with the following results:—

	1.	2.	3.	4.	5.
August 8th.....	12.0	12.4	17.7	10.4	17.5 cm.
" 10th.....	24.5	19.0*	25.0*	20.5*	33.0*
Gain.....	12.5	6.6	7.3	10.1	15.5

* Indicates those which could not be fully straightened.

[1] Comparative Anatomy of Phenogams and Ferns. Eng. Ed. 200.

Coils 2, 3, 4, 5 could not be fully straightened for measurement, allowance for which had to be made. Thus if we add to the above numbers as follows: 1.0, 3.0, 5.0 and 1.0 cm. respectively, we then get as the total lengths of all the tendrils, 12.5, 7.6, 10.3, 15.1 and 16.5 cm. We thus get as the extreme range in elongation, from 50 per cent. to 100 per cent. of the original length, and the mean ratio of increase would be as 1 : 1.14, showing that the tendril at least doubles in length after the uncoiling from the bud, and during the period of circumnutation.

Coiling.—When brought in contact with an object near the tip, the tendril, at once affected by the irritation, coils about the support with a firm grasp. The effect of irritation does not immediately extend along the remainder of the tendril, as is shown by the fact that, when the tip is brought in contact, the basal portion of the tendril continues its movement and passes by as a curve, the sensitive surface thereby becoming convex instead of concave, as would occur if it felt the influence of contact. After a time, however, the effect of contact extends to all the cells of the basal portion, which then draws itself into a closer and closer spiral. When brought in contact with an object, the tendril does not immediately lose its power of nutation, but often retains it for a very considerable period, this being dependent upon the age of the tendril, and especially upon the particular state of lignification in the bast. It becomes evident, therefore, that when the tip is arrested, the bands of vibrogen, still continuing to act in the basal portions, tend to bow the tendril in all directions as before. Their power to do so being modified by fixation of the tip, the natural result would be for the centre to pass by the point of support as a curve having the sensitive side outermost. Continued circumnutation of the free central portion between two fixed extremities must result in torsion, which will be right or left hand as the case may be, from both ends towards the centre, and when such torsion becomes excessive, its compensation is of necessity found in a double spiral [1], which always characterizes the fixed tendril. If coiling in the free central portion were primarily due to the irritation of contact, we should expect to find the coiling first developed as the direct result of simple contraction along one side, and this would not immediately give rise to torsion. Tendrils which have not suffered contact, always coil upon themselves at the completion of their period of circumnutations. Such coils, however, are always somewhat loose and quite irregular, and are the direct result of excessive inequality of tension between the bast and vibrogen, therefore of unequal maturity in the tissues.

Circumnutation.—The circumnutations of the tendrils commence as soon as each arm uncoils from the bud condition. The central and largest arm generally uncoils first, and later, the laterals. The whole period of circumnutation in a rapidly growing vine, under favorable circumstances, is usually about two days—rarely three days. During this period, the motion is at first by grand and regular sweeps, but it gradually becomes slower as the end is reached; and in the later periods, the movement is spasmodic, often exhibiting rest periods alternating with those of great activity. Ultimately the end is reached in the formation of a spiral, which is more or less loose and irregular if free, or

[1] Darwin, Climbing Plants, 163, etc.

compact and well formed if developed after contact. In each case the structural modifications are the same, i.e. the parts become hard, dry and woody.[1]

The figure described by the nutating tip is approximately ellipsoidal (Plate III), the major axis being transverse. This axis not infrequently reaches a length of 24 to 27 cm.; that of the minor axis being from 13 to 22 cm. in length. In *Echinocystis lobota*, the diameter of the figure, according to Darwin[2], is even larger than this, measuring from 38 to 41 cm. While the tendril thus describes a figure, the vertical plane of which is parallel with the axis of the plant, the space through which the tip moves is greatly augmented by a supplementary movement in the growing end of the vine on which the tendril is found. This secondary movement causes the tendril to describe a double motion, which increases the possibility of its contact with surrounding objects.[3] It is of short duration, however, since the movement of the vine is confined to the few internodes at the end, and at any one node continues for two days only after the tendrils are in motion; so that, by the time the first arm of the latter has grasped a support, the movement of the vine at that particular node may have ceased entirely. So long as there is no contact the tendril continues to revolve, until a gradual increase of permanent tissue arrests its activity.

Circumnutations do not belong to the tendril arms alone. Not only does the petiole of each tendril perform a definite circumnutation, but the leaves exhibit a similar movement in a marked degree, as demonstrated by G. E. Cooley during the past summer. The motion of the tendril petiole is best observed by Darwin's method of a fine glass filament with a small black bead at its extremity, inserted into the end of the petiole where the arms separate. The circumnutation of the leaf is to be determined from its tip, as in tendril motion. In this manner, we have obtained, from a leaf of medium size, a figure of twenty different changes of direction, within the space of three hours. The movement was found to be much slower, and the figure much smaller than in the case of the tendrils. This, however, would appear to be the case from theoretical considerations, when we compare the structural features of the two and have due regard for the difference in size. The figure described by the leaf, so far as formed, was quite regularly ellipsoidal, though the curve was retraced before the ellipse was fully completed, in all of these respects showing striking similarity to the movement of the tendril.

During a series of observations extending over a period of nearly one week and embracing both day and night, almost the entire circumnutations of each tendril observed were secured. Temperature and other conditions were noted at each of the observations, which were taken at intervals of from two minutes to one hour, according to the condition of activity. The following are the results :—

Tendril No. 1.—Aug. 12th, at 9.30 a.m., one of the longest arms was selected after it

[1] My observations confirm those of Darwin with regard to other members of the Cucurbitaceæ, that when a spiral develops freely, it is always simple; that it only reverses when the tip is attached to a support.

[2] Climbing Plants, 128, etc.

[3] The fact that there is this double motion as a result of tendril vine action, shows that the true figure is to be obtained only when the tendrils revolve about the inner surface of a glass globe and the changes of direction are recorded from the outside. This, however, was not practicable in our case, nor was it essential to the accuracy of the conclusions to be obtained. For our purpose, the plane recording surface was amply sufficient.

had been sometime uncoiled, and its movements were noted until there was no further motion. The entire period of observation was ten hours and thirty minutes. During that time, the tendril tip traversed a distance of 343.15 cm., giving an average rate of 0.54 cm. per minute.

The greatest rate of movement, at any one time, was 2.06 cm. per minute, and occurred two and one-half hours after the wave of maximum temperature had passed. The waves of most rapid movement extended from 2.30 to 4.30 p.m., closely following the greatest heat wave. The waves of slowest movement covered the time from 10 a.m. to 2.30 p.m., coincident with a rising temperature. The absolute minimum of motion occurred just before the maximum of temperature, at the rate of 0.21 cm. per minute. At four o'clock in the morning, a heavy rain ceased. The air was surcharged with moisture, and the sky was entirely overcast with heavy clouds. It was while this condition lasted, that the waves of slowest motion occurred, the absolute minimum being found during the period from 12.15 to 1 p.m. At the latter hour, the clouds broke and the sun came out brightly and so continued until 6 p.m., when the sky again became overcast and rain set in at 7 o'clock. While the sun was out, the tendril was most active—the absolute maximum of motion taking place within the five minutes from 3.25 to 3.30 p.m., the distance travelled in that time being 16.30 cm.

The first direction of movement was to the right. This, however, was obviously accidental, since the direction first recorded must depend upon the time of first observation with relation to the entire movement—dextrorse alternating with sinistrorse movement during the whole period of activity. The total motion to the right was 190.8 cm.; that to the left, 152.35 cm.; and the ratio therefore, as 1 : 0.79.

Tendril No. 2.—Selected for observation, August 13th, at 8 o'clock. It was a shorter arm than No. 1, and somewhat nearer the end of activity. The time of observed movement was six hours and fifteen minutes, and the whole distance travelled 136.00 cm., thus giving an average rate of 0.36, cm. per minute.

The absolute maximum of motion was 1.76 cm. per minute and occurred from 10.15 to 10.20 a.m., forty-five minutes before the maximum temperature for the day was reached. The waves of most rapid motion covered the period from 8 to 10.50 a.m., coincident with increasing temperature. The waves of least motion occurred between 10.50 a.m., and 2 p.m., during a slight depression of temperature. The absolute minimum was reached between 10.50 a.m. and 12.25, and amounted to 0.179 cm. per minute. It directly succeeded the maximum of temperature. During the entire time of observation, the weather was very pleasant, though somewhat cloudy. At 12 o'clock, the leaves began to droop from the effects of excessive heat and transpiration. This continued until after the close of observations. It was during this time of depressed activity, that the minimum motion occurred. During the entire morning, all the leaves and flowers showed great vigor, and it was while in this condition that most active movement took place. The first motion observed, was to the left, and was not replaced by dextrorse for some time. The entire sinistrorse action was 94.2 cm.; the dextrorse, 41.8 cm.; and the ratio of the latter to the former was therefore, as 1 : 2.25.

Tendril No. 3.—The time of observation was ten hours and thirty minutes, commenc-

ing at 10 o'clock, a.m., on August 13th. The whole length of movement was 329.30 cm., and the rate per minute, 0.52 cm. The times of greatest movement were from 1 to 3.15 p.m., and again from 5.15 to 8 p.m., the former occurring at the time of the maximum temperature, the latter on a diminishing temperature. The absolute maximum of motion was 3.55 cm. per minute, and occurred from 1.50 to 1.52 p.m. succeeding the wave of maximum temperature by two hours and fifty minutes, at a time when there was a slight temporary depression of heat. The distance travelled in that short interval was 7.10 cm. The time of least movement was from 12.15 to 1 p.m., during the time of greatest heat, and again from 3.15 to 5.15 p.m., following a diminution of temperature. The absolute minimum of motion was 0.013 cm. per minute, and occurred from 12.15 to 1 p.m. on a decreasing temperature, following the maximum wave by one hour and fifteen minutes. During that time, the weather was pleasant but somewhat cloudy. From 11 a.m. until 5 p.m., all the leaves and flowers were drooping, indicating a weak vital action through excessive transpiration. The first movement recorded was to the right, soon succeeded by a reverse to the left. The entire amount of the former was 261.5 cm. ; of the latter, 67.8 cm. ; and the ratio as 1 : 0.25.

Tendril No. 4.—This tendril was taken August 14th at 8 o'clock a.m., but so late in its growth that only twelve movements were obtained, covering seven hours and fifty minutes in all. The whole length of movement was 66.20 cm., and the average rate per minute, 0.14 cm. At no time was there any exhibition of very great activity, the tendril appearing to move as if in the last stages of growth, which it really was. The most rapid movement appeared from 9.41 to 9.50 a.m., the extremity passing through 7.7 cm. in nine minutes—an average rate of 0.85 cm. This coincided with the highest temperature, and was just prior to a fall of two degrees. The time of least activity was from 9.50 a.m. to 3.50 p.m. The absolute minimum of motion was from 2.10 to 3.50 p.m., amounting to 0.031 cm. per minute. It occurred on a decreasing temperature, five hours and fifty minutes after the maximum temperature had passed. During that time the sun was shining brightly, though its effects were somewhat modified by numerous clouds. From 12 o'clock to the close of observations, during the time of least activity, the leaves and flowers were all depressed from the effects of the heat.

The movements first recorded were to the left, but after two courses changed to the right. The total dextrorse movement was 18.4 cm.; the sinistrorse 47.80 cm., and the ratio 1 : 2.6.

Tendril No. 5 a.—This was taken Aug. 14th, at 4 o'clock p.m., as soon as it had emerged from the bud condition ; thus very nearly the first nutations were secured. Observations were interrupted after a few hours, and not resumed until the next morning. The entire length of movement was 107.60 cm., occupying four hours and thirty minutes, thus giving an average rate per minute of 0.39 cm. The greatest movement was at the rate of 1.44 cm. per minute, and occurred from 4 to 4.05 p.m., at the very commencement of action and observation. The times of greatest movement occurred from 4 to 4.35 p.m., and again from 5.30 to 7 p.m., coincident with decreasing temperature.

Least activity was noticed at 7.55 to 8.10, when the tip moved at the rate of 0.13 cm. per minute. This occurred at the time of lowest observed temperature, the mercury

standing at 21° C. The times of least movement were found to extend from 4.35 to 5.30, and again from 7 to 8.30 p.m., when the observations ceased.

At the commencement of observations, the sun was shining brightly, and the effects were sufficiently strong to cause a depression of all the leaves and flowers. Shortly after observations ceased, the sky became cloudy, and at 9 o'clock there was a heavy shower which revived the whole plant, and once more brought all the parts into active condition.

The first movement recorded, was to the left, action in that direction predominating during the entire period of observation. The total movement to the right was 18.80 c.m.; to the left 88.8 cm.; and the ratio, therefore, as 1 : 4.72.

Tendril No. 5 b, c.—This represents the same as the preceding tendril, observations upon which were interrupted Aug. 13th at 8 p.m., and resumed the next morning (14th) at 8 o'clock, being continued through the 14th and 15th. During the night, the arm was quite active, and in the morning showed no tendency whatever to discontinue its nutations. From the time indicated, observations were continued for twenty-four consecutive hours. The entire distance travelled during that time was 511.7 cm., thus giving an average rate of 0.37 cm. each minute. 5 b-c. indicates a change of paper, which occurred at 6.20 p.m., at a time when the tip had dropped to the ground, where it remained without change of position until 8.35 p.m., when its nutations were resumed.

The time of most rapid movement, was during the two minutes from 4.55 to 4.57 p.m., on a decreasing temperature, and five hours after the maximum wave had passed. The rate of movement was 4.55 cm. per minute, the times of most rapid movement occurring from 8 to 10.20 a.m.; 1.30 to 2 p.m.; 4 to 5.30 p.m., and 10.53 to 11.05 p.m.; the maximum of these being from 4 to 5.30 p.m. The absolute minimum of motion occurred from 4 to 5.04 a.m., when the tip traveled at the rate of 0.043 cm. per minute, this being at a time of low temperature. The times of least activity were from 10.20 a.m. to 1.30 p.m.; 2 to 4 p.m.; 5.30 to 10.53 p.m.; and from 11.05 during the remainder of the night, and until the end of the experiment at 7 o'clock in the morning. In these observations, there appears a very sharp division at 5.30 p.m., between the waves of more rapid diurnal, and those of slower nocturnal movement.

The experiment commenced with very pleasant weather and all parts of the plant in vigorous condition—the leaves being erect and the flowers open. From 12 m. to 4 p.m., the leaves were drooping and the activity of the plant small. This, with the exception of one-half hour from 1.30 to 2 p.m., was a time of slow movement. At 4 o'clock p.m., the leaves began to resume their normal, fresh appearance and so continued until the close of observations. Towards morning, a very heavy fog gathered and reached its maximum at four o'clock, the time of minimum motion.

Sinistrorse movement was first noticed. The entire dextrorse motion was 282.1 cm.; the sinistrorse 229.6, and the ratio 1:0.81, thus showing a greater tendency to equality than previously observed.

The figure described during the movement of this tendril—reduced to one-half the actual size—is shown in Plate III, the position of the observer corresponding to the base of the tendril. The following table relating to these movements will convey a fairly accurate idea of the general features of circumnutation with reference to time and distance :—

Number.	Distance in cm.	Time.	Temp. deg. C.	Number.	Distance in cm.	Time.	Temp. deg. C.
1	.0	8.00 A. M.	24.4	29	9.1	4.57 P. M.	.....
2	11.6	8.25 "	.....	30	10.0	4.60 "	.....
3	8.7	8.40 "	.....	31	5.7	5.02 "	3.05
4	20.6	9.15 "	35.5	32	3.2	5.05 "	.....
5	14.8	9.40 "	.....	33	1.9	5.10 "	.....
6	29.6	10.00 "	35.5	34	20.8	5.30 "	.....
7	10.1	10.15 "	.....	35	6.0	5.32 "	.....
8	7.0	10.20 "	.....	36	8.1	5.40 "	.....
9	18.2	11.00 "	36.6	37	14.1	6.20 "	27.2
10	7.0	11.25 "	.....	38	6.3	8.35 "	22.2
11	7.2	12.00 M.	36.6	39	4.6	8.47 "	.....
12	7.8	1.00 P. M.	33.3	40	14.7	9.00 "	22.2
13	8.0	1.15 "	.....	41	6.8	9.50 "	21.1
14	7.3	1.30 "	.....	42	18.8	10.55 "	.....
15	18.8	1.35 "	.....	43	7.5	11.05 "	21.1
16	5.7	1.45 "	.....	44	9.0	12.00 "	20.0
17	5.3	1.55 "	.....	45	15.1	12.35 A. M.	.....
18	8.8	2.00 "	32.2	46	7.2	1.00 "	20.0
19	7.4	2.20 "	.....	47	25.9	2.00 "	19.0
20	5.7	2.45 "	.....	48	8.2	2.20 "	.....
21	4.1	3.00 "	32.2	49	9.7	4.00 "	18.0
22	6.4	3.20 "	.....	50	2.8	5.04 "	19.0
23	17.5	4.00 "	32.2	51	9.4	5.30 "	.....
24	3.5	4.10 "	.....	52	6.0	5.45 "	19.0
25	9.9	4.30 "	.....	53	6.6	7.00 "	20.0
26	10.2	4.45 "	.....				
27	6.8	4.50 "	.....	Totals..	511.5	23 h.	577.8
28	6.0	4.55 "	.....				
				Means..	9.8	26.5 m.	26.3

Tendril No. 6.—Selected Aug. 1, at 1.45 p.m., when but a short time from the bud. Observations were continued consecutively for eighteen hours and fifteen minutes. The distance through which the tip moved during that time, was 327.8 cm., an average rate per minute of 0.29 cm.

Most rapid movement occurred from 6.50 to 6.52 pm., at the rate of 6.5 cm. per minute. This was on a decreasing temperature, and six hours and forty minutes after the wave of

maximum temperature had passed. The time of the greatest movement was from 3.50 to 7.10 p.m. on a decreasing temperature, and within three degrees of the lowest phase of the thermal wave. The times of least movement were from 1.45 to 3.50 p.m., and from 7 p.m. to the close of observations. As in the preceding case, there was, in this, a marked distinction between the waves of more rapid diurnal, and those of slower nocturnal movement—the time of division being 7 p.m.

The tendril commenced its nutations with a dextrorse movement, and in its entire activity manifested a greater equality between right and left motion, than in even the last case. The dextrorse movement was 166.10 cm.; the sinistrorse 161.7 cm., and the ratio, therefore, 1 : 0.97. At the commencement of observations, the sun was bright, and the temperature high. The vitality of the plant was much depressed, and the action slow—all the parts drooping from excessive transpiration. This continued until 4 p.m., during which time there were slow waves. At 4 o'clock, the plant revived, the leaves became erect, and the normal condition and activity were once more restored. From that time until sunset, the waves of greatest movement occurred. The sky was clear until after midnight, but slow waves continued throughout the remainder of the night, with a slight acceleration just after sunrise.

Tendril No. 7 a.—Observations commenced Aug. 16th, at 9 o'clock, a.m, and were continued for ten consecutive hours. The total distance covered, during that time, was 227.1 cm., or at the rate of 0.38 cm. per minute. The time of most rapid movement was from 5 to 5.20 p.m., when the tip moved at the rate of 0.92 cm., per minute. This occurred just at the outset of a rapid decline in temperature, and six hours after the maximum of temperature had passed. The time of greatest movement was from 3.15 p.m. to the close of the observations at seven o'clock, co-incident with a rapid decline in temperature.

The time of least movement was from 1.42 to 2.25 p.m.; the tip moving at the rate of 0.53 cm. per minute. This was during high temperature, but one hour and forty-two minutes after the maximum had passed. The waves of least motion were found to extend from 9 a.m. until 3.15 p.m., with a marked retardation towards the latter hour. These waves were coincident with the greatest heat wave, the greatest retardation of motion occurring just after the maximum temperature had passed.

The experiment commenced with the sky clear and the plant in active condition. As the heat increased, however, its effect upon the plant was noticed, and at 12 o'clock, with the mercury at 34.4° C., the leaves drooped, and the whole plant was in a very flaccid condition. During this time, the waves of slowest motion occurred. This condition continued until, with considerable fall in temperature during the afternoon, the normal tension and activity of the plant were restored, when the waves of greatest activity were noted. The entire dextrorse movement was 92.90 cm.; the sinistrorse 134.20 cm., and the ratio as 1 : 1.44.

Tendril No. 7 b, c.—This was the same as the preceding, observations upon which were discontinued during the night, but resumed on the morning of the 17th at 8 o'clock, and carried over a period of seven hours and fifty minutes. The entire movement during this time was 94.40 cm., giving an average rate per minute of 0.205 cm. Most rapid movement was at the rate of 0.555 cm. per minute, and occurred from 8 to 8.15 a.m., at

the very commencement of observation, and on a rising temperature, six hours before the maximum was reached. The waves of most rapid motion were found from 8 to 11.30 a.m. Least motion took place at 1.30 to 2 p.m., at the rate of 0.08 cm. per minute. This was just at the time of maximum temperature. The waves of least motion were found from 11.30 a.m. to the close of observations at 3.40 p.m., coincident with a rising and maximum temperature.

Observations commenced with a moderate temperature, clear sky and an active condition of the plant, continuing thus during the time of greatest movement, until, at 11 o'clock, the leaves became depressed from the effects of the heat, and from 11.30 on, the waves of slow motion were found. At 12 m., the sky was overcast and the air loaded with moisture. At 1 p.m., the leaves were restored to their normal condition and erect position. At the same hour, rain commenced and continued during the remainder of the experiment. The total movement to the right was 25.10 cm.; to the left, 69.30 cm., and the ratio as 1 : 2.76.

Tendril No. 8 a.—Selected Aug. 16th, at 9 a.m.—The time of observation covered a period of nine hours and fifty minutes, or until 6.50 p.m. The entire movement during that time was 314.50 cm., giving an average rate per minute of 0.516 cm The time of greatest movement was from 3 to 3.15 p.m., and the rate per minute 1.20 cm. This was on a decreasing temperature, four hours and fifteen minutes after the maximum. The waves of greatest movement were found from 2 p.m. until the end of observations, and during a diminishing temperature.

The time of least movement was from 11.25 to 11.40 a.m., and the rate per minute 0.166 cm. This was at the time of maximum temperature. The waves of slowest motion extended from 9 a.m. until 2 p.m., with slight acceleration of movement towards the latter hour. Observations commenced with a bright sun and the plant in active condition. At 12 o'clock, the leaves drooped, with the thermometer at 34.4° C, and this condition continued until early in the afternoon, when they revived with decrease of heat. It was during the passive condition of the plant that the slowest motions were observed, the more rapid waves occurring with renewed vigour and greater tension of parts. The entire dextrorse motion was 143.10 cm.; the sinistrorse 161.40 cm., and the ratio, therefore, as 1 : 1.12.

Tendril No. 8 b.—Observations were resumed at 8 o'clock a.m., August 17th, and were continued for seven hours and forty-five minutes. The distance which the tip travelled during that time was 225.0 cm., or at the average rate of 0.483 cm. per minute. The greatest movement was at the rate of 2.60 cm. per minute, occurring from 3.40 to 3.45 p.m., at the very close of observations and one hour and forty-five minutes after the maximum of temperature. The waves of most rapid movement were from 3.15 to 3.45 p.m. Least movement occurred at 10.15 to 10.30 a.m., at the rate of 0.10 cm. per minute. The waves of least motion extended from 8 a.m. until 3.15 p.m., coincident with a rising and maximum temperature. Observations commenced with a bright sun and the plant active. At 11 o'clock a.m., just thirty minutes after the minimum of motion occurred, the leaves were all drooping as a result of excessive transpiration. At 1 o'clock p.m., it was raining, and the normal activity of the plant was restored. This continued

until the close of observations. The entire dextrorse action was 103.50 cm.; the sinistrorse 121.50 cm., and the ratio, therefore, as 1 : 1.17.

Tendril No. 8 c.—Observations upon the tendril were resumed on the 17th of August, at 5 o'clock p.m., and extended over fifteen hours. Apparently, on account of its age, and the time of observation, the entire movements were slow, amounting in the whole period to only 159.0 cm., thus giving an average rate per minute of 0.176 cm.

The greatest movement was from 7.12 to 7.28 p.m., at the rate of 0.65 cm. per minute. The waves of most rapid movement were from 5 to 7.30 p.m., with a slight acceleration in the morning. Least movement was found from 2.30 to 3 p.m., at the rate of 0.023 cm. per minute, occurring at the time of minimum temperature. The extreme variation of temperature during the time of observation was only 2° C. A light rain fell during the greater part of the time, and heavy clouds obscured the sky the remainder. The dextrorse movement was 117.6 cm.; the sinistrorse 41.40 cm., and the ratio as 1 : 0.35.

Tendril No. 9.—The last tendril experimented upon was taken August 17th, at 6 o'clock p.m. It was in the last stages of movement, and exhibited the least horizontal range. The whole length of movement was 191.30 cm.; the time sixteen hours and forty minutes, and the consequent average rate per minute was 0.191 cm.

The greatest movement was from 7 to 7.06 a.m., at the rate of 2.17 cm. per minute. This occurred from 9.30 to 10.00 p.m., at the rate of 0.02 cm. per minute. The waves of slowest motion were found from 6 p.m. until 5 a.m. The temperature varied only three degrees during the entire time of observation. From the commencement until 10 o'clock p.m., light rain fell and the sky was entirely overcast until the close of observations. At 5 a.m., there was a cool east wind, with a very large amount of moisture in the air, and the plant was in a very active condition. At the close of observations, heavy rain commenced to fall. The total dextrorse motion was 160.40 cm.; the sinistrorse 30.90 cm.; and the ratio as 1 : 0.181.

General Summary.

Average Rate of Movement.—From a total of 436 distinct observations upon the motion of the tendril under all conditions of temperature and humidity, it is reasonably safe to assume that the average rate of movement deduced from them, will represent with approximate accuracy, the true normal rate of movement under all the ordinary conditions of growth. This rate we find to be 0.316 cm. per minute.

Maximum Rate of Movement.—By reference to the accompanying table, it will be seen that the maximum rates vary very widely, and also, in the same tendril, that they usually occur in waves, as in 5 *a*, 5 *b*, *c*, etc.

RELATION OF TEMPERATURE TO RATE OF MOVEMENT.

(Deg. C. Distances in cm.)

	1.	2.	3.	4.	5*a*.	5*b*, *c*.	6*a*, *b*.	7*a*.	7*b*.	8*a*.	8*b*.	8*c*.	9.	Means.
Average rate per minute..	0.54	0.36	0.520	0.140	0.39	0.370	0.290	0.380	0.205	0.516	0.483	0.176	0.191	0.304
Max. rate of movement. ..	2.06	1.76	3.550	0.850	1.44	4.550	6.500	0.920	0.555	1.200	2.600	0.650	2.170	2.216
Temp. for max. rate..	28.30	26.10	27.800	35.500	27.20	30.900	24.400	29.000	20.000	31.700	22.200	20.500	21.100	26.500
Minute rate of movement. ..	0.21	0.18	0.013	0.031	0.13	0.043	0.047	0.053	0.080	0.166	0.100	0.023	0.020	0.084
Temp. for min. rate	31.10	31.70	29.500	32.200	21.70	16.700	21.100	31.100	22.800	34.00	24.000	19.500	20.000	27.300

If we examine these results in their relation to the external conditions of growth, then we find that, of the thirteen observations given, only four show waves of rapid movement during the morning, these occurring between the hours of 7 and 10.20, and in no case—unless we except No. 9—representing the *absolute maximum of motion for the whole life of the tendril.* The remaining nine show the waves to occur in the afternoon, from 1.50 to 7.12 o'clock. If, moreover, we select those figures which represent the true maximum of motion for the entire period of activity in each tendril, we shall find that only one such occurred in the morning, all the others taking place in the afternoon, between the hours of 1.50 and 6.50.

Equalizing the hours of day and night, making the time of division 7 a.m. and 7 p.m., we find the total length of diurnal movement to be 1359.90 cm.; and of nocturnal movement to be 536.90 cm.; thus making the latter in the ratio of 1 : 2.53 to the former, a difference which clearly indicates that temperature exerts an influence which far outweighs any retarding effect due to the greater influence of sunlight.

This naturally raises a question relative to the temperature under which these maxima were obtained. The values for tendrils 1, 3, 5 *b*, *c*, 6 *a*, *b*, 8 *b*, and 9, the six highest rates observed, were obtained when the temperature ranged from 21.1° C. to 30.9°. Of these, the highest rates, viz., 6.50, 4.55, and 3.55, were obtained when the thermometer ranged from 24.4° C. to 30.9°; the other three giving values of 2.17, 2.60 and 2.06, were obtained between 21.1° C. and 28.3°. We thus find that the more active of these waves were formed under the influence of a temperature 3.8° C. higher than that under which the less active were produced. Again, taking the highest rate of each tendril movement —including those just given—we find them obtained under an average temperature of 27.2° C.; while the waves of rapid movement in the same tendrils, but of less amplitude, were propagated under an average temperature of 24.8° C. Of the thirteen maxima of movement obtained, one was found to be coincident with the absolute maximum of temperature. This, however, was a movement at the low rate of 0.85 cm. per minute. Three were found to occur on an increasing temperature, usually several hours before the maximum was reached; and nine were observed on a descending temperature, from two to six hours after the maximum for the day had passed.

Passing to the condition of the atmosphere in other respects, we find that the maximum movements in tendrils 1, 8 *b*, 8 *c* and 9 were reached under conditions of great

humidity; of all the remainder, when the sky was clear and the sun bright. The rates of movement in the four tendrils just mentioned were respectively 2.06, 0.65, 2.6 and 2.17 cm., and were attained when, owing to the humidity of the air, transpiration was not very active. Tendrils 2, 3, 4, 5 *a*, 7 *a*, *b* and 8 *a* gave respectively 1.76, 3.55, 0.85, 1.44, 0.92, 0.555 and 1.2 as the maximum of motion. These rates were all reached while transpiration was excessive, and the effect of this upon the plants so great that all the leaves, flowers and buds were drooping. Tendrils 5 *b*, *c* and 6 *a*, *b*, in which the highest maxima were reached, gave respectively 4.55 and 6.50 cm., but these rates were reached under conditions of active, though not excessive, transpiration, clear sky and bright sun, and while the plant was in a normally active condition, as shown by the erect leaves and fine healthy color of all the parts.

Minimum Rate of Movement.—Of the thirteen minimum movements recorded, we find that five occurred between sunset and midnight, two between midnight and sunrise, three between 10 a.m. and 1 p.m., and three between 1 and 4 p.m. We further find that four occurred during a minimum temperature; four just before the maximum; two just after, and three at the very time of maximum.

As in our previous division, taking the figures obtained for 6 *a*, *b*, 3, 5 *b*, *c*, 1, 8 *c* and 9 as representing the true minima for the entire movement of each tendril, we find the average temperature at which these movements occurred to be 22.9° C., while the average temperature for the whole thirteen is found to be 25.8° C. The remaining seven movements of greater rapidity were found under the influence of an average temperature of 28.2° C. The following table will show the connection between temperature and rate of movement, as just explained:—

Maximum movements.....		13	26.5° Mean Temperature.
Minimum "		13	25.8° " "
Maximum "	(*a*) rapid.....	6	27.2° " "
" "	(*b*) slow.	7	24.8° " "
Minimum "	(*a*) slow.	6	22.9° " "
" "	(*b*) rapid.....	7	28.2° " "

From this it will appear that a higher temperature is favorable to the more rapid movements, to a greater activity of the whole plant.

Referring to the atmospheric conditions, it is found that tendrils 6 *a*, *b* and 1 gave their minima of movement during pleasant weather, while the plant was apparently in an active condition. The rates per minute were .047 and 0.21 cm. respectively. Tendrils 7 *b*, 9, 5 *b*, *c* and 8 gave 0.08, 0.02, 0.043 and 0.013 cm. respectively, during a time of great moisture and even rain; 8 *c* gave 0.025 cm., during the time of a heavy fog and cold east wind. The remainder, 4, 7 *a*, 2, 8 *b*, 8 *a* and 5 *a*, gave respectively 0.031, 0.053, 0.18, 0.10, 0.166 and 0.13 cm., at a time when transpiration was excessive, as shown by shown by the drooping leaves and terminals, and always during a very bright sun.

Dextrorse and Sinistrorse Movements.—The circumnutations of the tendril tip

may commence in a direction with the sun, or the reverse. Movement in either direction is by no means continued during the entire period of activity. Motion in one direction may soon be succeeded by movement in the other direction, one alternating with the other constantly. The dextrorse motion, for all the observations taken, aggregated 1622.10 cm., the sinistrorse amounted to 1400.95 cm., and the ratio of one to the other was, therefore, as 1 to 0.86.

While this shows a tendency to equality of movement in the two directions—a tendency which might have been more pronounced had the observations embraced all the movements—an important relation bearing upon this point is to be observed between the latitudes and departures of movements. Also, the relation which these two directions of motion bear to one another must obviously be directly related to the location of the bands of more active tissue which induce the motion. The following table will exhibit the total latitudes and departures for all the tendrils :—

Tendrils.	Latitudes.		Departures.		Ratios.
No. 1.....	.....	124.30	.....	249.70	1 : 2.01
" 2.....	.....	53.25	.....	116 60	1 : 2.19
" 3.....	.....	123.35	.....	269.40	1 : 2.10
" 4.....	.....	21.00	.....	60.83	1 : 2.89
" 5 *a*.....	43.37	285.17	91.10	489.65	1 : 1.71
" 5 *b, c*.....	241.80		398.55		
" 6 *a, b*.....	.....	141.75	.....	266.55	1 : 1.88
" 7 *a*.....	87 75	135.50	192.80	262.10	1 : 1.93
" 7 *b*.....	47.75		69.30		
" 8 *a*.....	106.30	227.15	264.70	612.23	1 : 2.69
" 8 *b*.	67.65		203.03		
" 8 *c*.	53.20		144.50		
" 9.....	.....	122.40	.....	118.15	1 : 0.95
Totals	.....	1193.87	.....	2445.21	1 : 2.04
Means	.....	91.84	.....	188.09	

An inspection of this table at once exhibits a most striking relation between latitudes and departures of motion. While in some cases there is a marked variation in the results, e.g., Nos. 4 and 9, yet these, as already seen, were tendrils which were only partially observed, and if we consider the mean result, which agrees with specific cases in which the entire action of the tendril was noted, we find the departures of motion to be just twice the latitudes. This indicates most conclusively, therefore, that the principal energy of circumnutation must be developed along the two sides of the tendril arm, and reference to our figures, as also the description of the histological elements, will at once show that it bears a most important relation to the three bands of vibrogen tissue.

Conclusion.

We may now proceed to sum up the conclusions which the foregoing facts appear to justify.

Temperature.—The observations here recorded are in harmony with the views generally held, that within certain limits and conditions, otherwise favorable, higher temperatures induce more rapid growth. According to the experiments of Sachs upon the germinating seeds of Cucurbita, the most rapid growth occurred under the influence of a temperature of 33.7° C.; the condition, doubtless, being such that the normal tension of parts was fully maintained throughout, or subject to but slight variations. In our own observations, the greatest growth, as represented in tendril movement, occurred under a temperature of 24.4° C.; while the most rapid growth of the vine occurred when the temperature ranged from 29° C. to 36.6°. It is important, however, not to lose sight of the fact that in these cases, there were important modifying influences which would affect growth through the normal tension of the tissues,—a disturbance of which frequently occurs as a result of high temperatures. The general effect of temperature becomes conspicuous at once, if we compare the growth for an even number of hours when the temperature is above 30° C., with growth for the same period when the thermal range is from 25° C. to 30°. We shall then find the growth in the latter case to be greater, as the following table will show:—

Number of Observations.	Average Temperature.	Total Growth.	Average Growth per hour.	Relative Humidity.
6	27.0° C.	2.0 in.	0.333 in.	Relatively great.
6	34.9°	1.6 in.	0.266 in.	Relatively small.

The relative humidity of the atmosphere, or the degree of saturation dependent upon temperature, exerts a direct influence upon conditions of tension in growing parts, and consequently upon growth itself, by inducing more or less rapid transpiration. Excessive humidity is consistent with more rapid growth. We may, therefore, reaffirm the already accepted principle that increasing temperature promotes growth, so long as it does not disturb the normal conditions of tension.

Light.—Alternations of day and night cause a marked influence upon and variations in the phenomena of growth. Light is generally accepted as exerting a retarding influfluence upon growth,[1] and other conditions being equal, we should naturally expect to find the greatest elongation of the axis and most rapid movement of motile parts during the hours between sunset and sunrise.

From the experiments now under consideration, we find that the growth during hours of darkness was in reality less than that during an equal number of hours of

[1] Sachs' Text-book, 755.

daylight, since, in the case of the tendrils, we obtained a movement of 1359.90 cm., for the day, against 536.90 for the night, and in the growth of the vine, 44.447 cm., for the day, against 34.287 for the night.

Rauwenhoff found that the growth in *Cucurbita pepo*, for twelve hours of day, was 56.9 p. c. of the whole, and only 43 p. c. for the same number of hours of night, thus giving a ratio 1 : 1.32 in favor of the former. Our results in the growth of the vine are in somewhat striking confirmation of this, since, as seen, our ratio is as 1 : 1.29 in favor of day light. In the case of the tendrils, the superior influence of conditions which obtain during the day becomes even more apparent. The one conclusion to be derived from these facts appears to be, that the superior influence of temperature in promoting growth overcomes the lesser and retarding influence which may be exerted by light.

From our previous considerations, it is clear that the movement of the tendril is but a normal manifestation of growth, and therefore subject to the same influences as other vital phenomena. These movements have been found to occur in well defined waves of greater and less activity, which, usually longer and of slower movement at the outset, are of decreasing length and greater activity with advancing age up to a certain period. This, however, is soon reached, and beyond this point the movements become somewhat longer, but more especially slower, with greater maturity. So long as all the tissues remain soft and in an actively growing condition, these waves will succeed one another in accordance with the controlling influence already spoken of. But as there is an advance in age with general hardening of the tissues and large formation of bast, a noticeable and general lengthening of the waves ensues. The tip may even drop toward the ground, as if exhausted, and not resume its nutations for one or even two hours. When it does, it is generally with a more sluggish action.

Growth in Length.—From previous considerations, it is clear that most rapid elongation and most active movement in the tendril, are simultaneous and directly correlated throughout the entire period of movement. It is, therefore, to this very rapid elongation in the first instance that we must look for a true explanation of the circumnutation. On the other hand, the structure of the tendril, presenting, as it does, a diversity of tissues, at once points to the fact that this rapid extension cannot be partaken of by all the tissues in equal degree. The vascular elements are those in which the least extension can occur of all the tissues present. With reference to all the other tissues, therefore, they must be brought into a state of positive tension which continually increases in strength as age advances and the constituent cells become more strongly modified. In the collenchyma also, while capable of greater extension and variation of tension than the wood and bast cells, yet with reference to the unmodified fundamental structure in active growth, there must be a well-pronounced positive tension. This fact is at once demonstrated by the changes which follow the cutting of sections. Transverse sections quickly bulge out in the centre with a strong marginal contraction. Longitudinal sections show a strong curvature with the concavity on the side along which the collenchyma lies. We may also, doubtless, ascribe a certain amount of this contraction to the effect of irritation, which causes a loss of water within the affected area, and thus, through condensation, a further increase of tension. This is essentially the view held by Sachs

(p. 869) and it certainly appears justified. We must, therefore, regard the collenchyma not only as influencing all the movements dependent upon growth, but also as that particular tissue which chiefly determines all movement caused by mechanical irritation, a view which is well supported by its presence in the tendrils of Vitis, Ampelopsis, Cucurbita, Sicyos and other vines, and the relations which it there bears to the movements of those tendrils.

The unmodified fundamental tissue, consisting of large, rounded, thin-walled cells filled with protoplasm and chlorophyll, is that in which the most rapid, general and continuous increase occurs. As the central or pith region early loses its power of growth and shrinks away radially, it may be regarded as having no special value in the movements, and we must look in this respect entirely to that parenchyma which lies without the wood zone. In all of the parenchyma tissue (Plate IV. Fig. 1) at *c* and *a*, there is found to be the greatest activity; and this power of extension is so strongly developed, that even after the vascular elements have assumed their most lignified condition, and the tendril has permanently coiled up, the vibrogen tissue at *a a'* will be found to retain its activity for some days. We must, therefore, infer, from this that the negative tension, as a whole, is developed most strongly in the parenchyma tissue, and particularly in the three bands of vibrogen which lie at *a a' a.''*

Torsion.—Sachs[1] distinctly states that no torsions occur in Cucurbitaceæ. This is not confirmed by our own observations, however, since it has been observed to be a common feature of the circumnutations, that distinct torsions constantly occur. This is readily determined, not only by the vibrogen bands, but by the changes in the direction of the recurved tip. Similar torsion is also readily detected in the petioles of both tendril and leaf, and that it bears a most important relation to the circumnutation itself can hardly be doubted. So strongly are these torsions developed in the tendril arm, that the tip frequently rotates through 180° or 200°. The explanation of this torsion is not difficult, and has been given on many previous occasions by various observers. From what has already appeared with reference to the various tissues in their mutual relations of position and tension, it is clear that torsion must follow as a natural result of excessive elongation in the external layers, thereby exerting a positive tension upon those which are internal.

Irritation.—Of the two sides of the tendril arm, that which is uppermost and slightly channeled is the least sensitive to contact. This bears a direct relation to the distribution of the collenchyma tissue, which we find to be more continuous and strongly developed on the lower and sensitive side. That the vibrogen tissue is not concerned in changes due to irritation, appears evident from the fact that the flexure never coincides with these bands, but is always toward the lower side of the tendril arm, conforming to the position of the collenchyma. The conclusion is justifiable, therefore, that the collenchyma tissue is that which is directly concerned in such movements, through its capacity for strong variations in the contained water.

A tendril subjected to local irritation for about thirty seconds, develops an abrupt curvature at that point within one or two minutes, and the bending continues so long as

[1] Text-book, 866.

the foreign body is in contact, and even for a few seconds after its removal. Puncture with a pin, or the action of a loop of thread, produces similar effects. Irritation over a more extended area causes a correspondingly larger curvature. There is no special evidence in such cases that the impulse has been conveyed beyond the limits of the area irritated, and soon after the irritant body is removed—the growth in the various tissues having become gradually restored to its normal condition—the tendril straightens out and once more resumes its circumnutations.

More violent mechanical stimuli produce a different effect, however. A sharp blow, such as would be given by a pencil, falling upon any part of the arm, produces an effect which throws the latter into a series of long undulations for its entire length. Prolonged irritation at the tip will usually produce the same effect. These facts at once and directly point to the inference that, while the effect is slowly produced, there is, nevertheless, a distinct transmission of impulse to very remote parts. Were concussion alone concerned, it might be possible to refer the whole change to it alone, as directly affecting the turgidity of the collenchyma tissue; but the fact that prolonged irritation will produce a similar result, should raise a question on this point. From what we now know concerning the sensitive nature of protoplasm, the relation which this substance bears to growth and turgidity, and its now well established continuity through living tissues, are we not justified in the belief that such transmissions as above noted are primarily propagated through this means?

Circumnutation.—Our attention is first of all called to the fact pointed out by Darwin,[1] and confirmed by our own observations, that the "tendrils revolve by the curvature of their whole length, excepting the sensitive extremity and the base, which parts do not move, or move but little." This clearly shows that whatever force is in operation, acts uniformly through the entire length of the motile organ, and that the movement has not a local origin at or near the base. We must, therefore, conceive, as both Darwin[2] and Sachs[3] explain, that there is a longitudinal band of more actively growing tissue which extends from base to tip, and thus the arm is bent over toward the side of less active growth. So far, our own observations are in strict harmony with these views, but they do not accord with the opinion that these bands "travel round the tendril and successively bow each part to the opposite side." As already shown, the figure described is not one of regular progression through successive points of an ellipse or other figure. (See Plate III.) In fact, the tip may change its direction very abruptly, often retracing the path just passed over (Nos. 36, 37 and 38), or the change may be less abrupt. While, therefore, it appears from the general equality of dextrorse and sinistrorse movement, that the totality of motion in one direction must be compensated by an equal movement in the opposite direction, the facts cited show quite conclusively that the band of growth does not pass regularly through successive points in the circumference, but that it arises irregularly. Again, the relations of the tissues in their mutual tension, and the position which the vibrogen tissue occupies, more especially the relation which this latter bears to the latitudes and departures of movement as already pointed out in a preceding paragraph, serve as a most important indication of the true position occupied by the bands

[1] Climbing Plants, 170. [2] *Ibid.* [3] Text-book.

of growth; and the conviction becomes more firmly impressed upon us that this position is not only fixed, but that it coincides with the vibrogen bands.

According to this view, all movement would be primarily due to these three bands, supplemented by less vigorous growth in the intermediate tissues. Therefore, all departures of motion would arise primarily from the two vibrogen bands traversing the sides of the tendril, and all latitudes of motion would be due to that vibrogen traversing the upper side of the tendril arm. Any deviation from strictly lateral or vertical oscillations must then arise as resultants of activity, either between two vibrogen bands, or between one vibrogen band and intermediate tissue of slower growth. Finally, the torsion already shown is to be regarded as having its origin in, and as compensating excessive growth in, one or all of the vibrogen bands of tissue.

Spasmodic Movement.—It has been noted that towards the end of the circumnutations, periods of rest alternate with periods of activity; that the whole action lacks vigor, and that there is a failure to accomplish those grand sweeps which are so conspicuous in the earlier period of activity.

These features are undoubtedly to be referred to gradually increasing lignification in the wood and bast cells, and the modified conditions of tension which necessarily result from this. As the bast cells, particularly, increase in thickness, their degree of resistance or of positive tension correspondingly increases, while at the same time the growth of the parenchyma tissues continues at a nearly uniform rate. So long as the bast remains thin-walled and capable of its maximum extension or response to conditions of external tension, for such period is the normal relation between it and the more actively growing tissue preserved, and this is marked by regularity and rapidity of motion in the whole organ. With excessive disturbance of the normal relations, the equilibrium is disturbed in the direction of the more resisting structure, and this finds expression, first of all in slow and spasmodic movement, and finally in the completion of the spiral, which is always developed freely, without contact, at the end of the period of circumnutation.

Coiling about a Support.—Coiling about an object with which the tendril comes in contact, has already been discussed indirectly, though it may be well to refer to one or two facts more particularly. The coiling of the tendril tip about the point of contact, is the direct result of irritation, as both Sachs and Darwin have already shown, and as the latter[1] explains, it is developed by a shortening of the side in contact with the object, the same change, i.e., condensation of structure and release of tension, operating here as in previous cases; and with Darwin, we can hardly agree with Sachs,[2] that the coiling is in any way due to accelerated growth in the unirritated side.

When once growth in length is arrested, as it appears to be soon after coiling is effected, the rapid hardening of all the parts appears to be the prevailing change. In this, however, it is difficult to conceive that the mechanical irritation has produced more than a very limited effect in advancing maturity. On the other hand, it rather appears that each tendril arm has a normal period of growth, which is completed only when the wood and bast cells have reached their full degree of maturity. If at the end of this period the

[1] Climbing Plants, 181.

[2] Text-book, 869.

tendril fails to secure contact with a suitable object, it coils up freely, as already shown, and this is the necessary consequence of the normal changes in the tissues. If, however, it comes in contact with an object of support, the tendril coils about it and accomplishes its double spiral within the normal period of its growth. This period cannot be prolonged for the purpose of finding a suitable support or completing imperfect changes. These must all be accomplished before the wood and bast tissue—the latter in particular—reach a certain stage in the development of their permanent character. This is well shown in the fact that old tendrils, which have failed to grasp a support until very near the end of their activity, manifest a striking loss of sensitiveness, and often catch hold but imperfectly, or if they gain a firm hold, fail to perfect their double spiral.

II.—Vitis cordifolia, *Michx.*

In the tendril of Vitis, not only with reference to its sensitiveness and general circumnutations, but more especially in its histological aspects, we have to deal with an organ which presents many features distinct from those of Cucurbita, the common ground of resemblance being found in functional similarity and in the way in which the circumnutations arise.

The tendril of the grape is a modified branch, bearing two smaller branches which serve a similar purpose. These branches, however, unlike those of the Cucurbita tendril, do not proceed from a common point of insertion, but arise successively on the elongating primary axis of the tendril as a whole. In their external aspects, they are well rounded, but somewhat flattened on the inner face toward the extremity, where the tip is strongly recurved. Throughout their length, the prevailing red color (*V. cordifolia*) is broken by ten narrow green lines, which are developed at approximately equal distances through the circumference. These are the bands of vibrogen corresponding to the three bands in the tendril of Cucurbita. Internally, the structure presents the features exhibited in Plate V. Figs. 1, 2, 3 and 4 A—during the earliest period of circumnutation—from which the following details may be gathered. The epidermis consists of a single row of thin walled cells with a strongly corrugated cuticle. Directly beneath this, lies a single row of pigment cells containing the red coloring matter. The hypodermal tissue consists chiefly of collenchyma, in which the angles are but slightly thickened (Fig. 3). As a whole, the tissue is quite continuous in most cases (Fig. 1, *cl*). Within the region of the hypoderma lie the ten vibrogen bundles, *v*, *v*, *v*, etc., which are well defined from the surrounding tissue, but somewhat variable in size. These bands, although they frequently penetrate the collenchyma deeply, do not always break its continuity. Next within the collenchyma is a thin layer of very active fundamental tissue, the cells of which are large and regular (Fig. 1, *pr*). It is within this tissue that, at a somewhat later period, the cambium arises as a well defined layer. Directly internal to this is the wood zone, or xylem portion of the vascular bundles. This, in the earliest periods of circumnutation, is composed of somewhat isolated and nascent vascular bundles, the elements of which are all very thin walled and rapidly increasing (Fig. 4 A). The only structural element remaining is the pith, which, as in Cucurbita, bears no special relations to the circumnutations.

As the tendril advances in age, several important structural changes occur. The whole hypodermal tissue increases slightly in thickness, and simultaneously the tissue in the region of each vibrogen band, and for the full depth of the zone, *cl*, becomes so modified that the component cells enlarge strongly—chiefly in a tangential direction—while they also become much more thin walled, and all traces of collenchymatous thickening disappear. This causes a strong localization of the collenchyma to the regions between the vibrogen bands, where it retains its original character (Fig. 3) without much change beyond an increase in the size of the cells. Within the region, *pr* (Fig. 1), there arises a layer of cambium which forms a continuous zone. From this arise bast bundles, one for each of the vascular bundles already noted. The former remain quite distinct to the end of their growth, and are usually widely separated. From the inner face of the cambium tissue, there arise new wood cells, which now become develcped so generally as to render the original bundles conjunctive, thus giving rise to a continuous zone of wood which continually increases in thickness.

At a very early period in its growth, each vascular bundle develops from two to three vessels and ducts. Ultimately, all the fibrous elements became highly lignified (Fig. 4 B). That this condition may be hastened in time, and possibly increased by contact, can hardly be doubted; but it is equally true that such changes occur normally where there is no contact, e.g., the sections here exhibited were taken from a freely coiled tendril.

In comparing the tendrils of Vitis with those of Cucurbita, several important structural differences become apparent. The much greater number of vibrogen bands in the former, and their somewhat regular distribution, at once suggest greater regularity in the figure described, as well as a general equality of motion in all directions. Also in Vitis, the inferior development of the collenchyma is consistent with, and may serve as a proper explanation of, the much lower degree of sensitiveness there manifested. While the general changes incident to maturity of parts are the same in any case, it is noteworthy that in Vitis there is no distinct zone of bast which fulfills the function of that tissue in Cucurbita, and upon the xylem portion of the vascular bundles must depend that resistance to general elongation which is so essential a factor in circumnutations; though undoubtedly, in this case, unequal growth of opposite sides is of far greater importance than unequal tension of component tissues, so that torsion would here be of less value as a factor, than in Cucurbita where it is generally more marked.

During the circumnutations, distinct torsions occur. These are readily determined by tracing the course of the vibrogen bands, from which it becomes apparent that the tendril is frequently twisted to the extent of one-half revolution upon its own axis. If no object is grasped during the active period, the tendril ultimately coils upon itself; but having grasped an object, it perfects a double spiral similar to that in Cucurbita. It is also noted that tendrils which have coiled freely, do not become so hard and dry as those which have secured attachment, from which it would appear probable that contact produces a more or less marked effect in accelerating, or, at least, in increasing the maturity and strength of parts, a view which gains strong confirmation also from the very marked differences in these respects to be found in Ampelopsis.[1]

It would thus appear that the general features of circumnutation in Vitis and Cucur-

[1] Darwin, Climbing Plants, 148.

bita are the same, and that they may be regarded as representing a particular class of movements, so far as their mode of production, as well as their general external features, are concerned. It is not as yet possible to say how far each of these may represent the type for the family; but from the similarity of the structure and circumnutation presented by Sicyos and other Cucurbitaceous vines, it is perhaps safe to infer that, in that case, Cucurbita is the type of the family.

The deductions which the preceding facts justify are as follows:—

1. Movements of circumnutation arise through unequal growth of the tissues, which is chiefly represented by the vibrogen bands.

2. The bands of more active growth are strictly localized.

3. Movements due to irritation depend upon continued elongation of the opposite side, together with cessation of growth and contraction in the irritated parts.

4. The collenchyma tissue is that which is chiefly concerned in variations of tension under mechanical stimuli.

III.—Robinia pseudacacia, *L.*

In the Robinia, there is not only an entirely distinct variety of motion, but also a motile organ which differs widely in many respects from the plants that we have previously considered. In this case, the special organ endowed with motion, is the leaf, which, instead of serving as a prehensile organ, is invested with the power of movement, for reasons directly connected with its own preservation against sudden and extreme atmospheric changes. Unlike tendrils, therefore, such motile leaves are found to present certain periodic changes of a most conspicuous character. They are, moreover, in most cases, supplied with a special cushion or pulvinus, through which the motion is primarily determined. As a whole, such movements present a certain relation to those already discussed, in that they may be regarded as modified circumnutations.[1]

Pulvinus of the Leaf.—Each pulvinus surrounds the base of its corresponding petiole as a cushion, conspicuously larger below than above. It extends upward from the point of insertion of the petiole, for a distance of 4.5 mm. to 7.0 mm. Its diameter is variable, increasing with age of the leaf, but apparently much more dependent upon the rankness of growth in the plant as a whole, since the largest pulvini are invariably found upon rank growing suckers. Under these circumstances, the diameter has been found to vary from 3.0 mm. to 5.0 mm., the mean size being not far from 4.0 mm. Externally, with a smooth and shining surface and very firm throughout, it possesses all the features of high tension. Of uniform size throughout, its strongest development is on the lower side of the petiole, while above it often but slightly exceeds the petiole itself. At the base on the lower side, just at the point of insertion, there are two triangular depressions in the pulvinus, formed by three ridges, one of which is central and strongly developed, while two are lateral and less strongly defined. All these ridges extend downward from the base of the pulvinus for some distance on the stem, and serve an important mechanical purpose, as braces or supports to the leaf. Directly interior and corresponding to the

[1] Darwin, Movement of Plants, 280, etc.

depressions noted, and thus occupying the extreme base of the pulvinus, is a large intercellular space, into which project numerous coarse, straight, sharp-pointed and thick-walled intercellular hairs. As seen in transverse section, this space lies within the lower half of the pulvinus, while the vascular structure is divided into three bundles, which traverse the projecting ridges referred to above, and thus it passes by the intercellular space on its lower side, in the extreme peripheral portion of the pulvinus. That portion of the pulvinus which lies on the upper side of the intercellular space, is quite uniform both externally and internally, and presents only those internal modifications of the normal tissues which are essential to its character as a pulvinus. In its structural details, other than these, the pulvinus may be characterized as follows :—

The epidermis is simple, the cells of equal diameter or slightly elongated tangentially; the cuticle is thin. The hypodermal tissue, which constitutes the pulvinus proper, and extends, without modification, to the bast zone, is of the same kind throughout, and consists of simple, round-celled parenchyma, with moderately thin cell walls. The cells show no essential variation in form, though in size they are usually much the largest in the central region. Throughout this tissue, continuity of protoplasm may be readily determined by the methods already stated. In the centre of the pulvinus and completely surrounded by it, is the fibro-vascular structure which forms the base of the petiole. In this vascular axis, the various tissues of the stem—pith, wood, cambium and bast—may be readily distinguished. The pith has the outline of an equilateral triangle with its base facing the upper side of the pulvinus, thus conforming to the external configuration of the pulvinus as a whole, as well as to the general outline of the other tissues. The cells of the pith are small and usually with medium-thick cell walls, though in some cases, especially toward the base of the pulvinus, they become very thick. The wood zone is well defined, and completely encloses the pith. The medullary rays are very prominent, but the most striking feature is the presence of numerous pitted ducts and vessels, which, from their long diameter, conspicuously thick walls and regular radial arrangement, at once attract notice. Among them, there appear, in much less conspicuous manner, the wood cells, which are small both in length and breadth. Surrounding the wood is a somewhat narrow zone, which, in its earlier periods of growth, is meristematic, and provides for radial extension of the wood zone. It possesses the usual characteristics of such tissue. The bast zone forms a continuous tissue. The cells are of small diameter, but very long and fusiform. The walls are of medium thickness and traversed by numerous pits, which terminate at the intercellular substance. During the activity of the pulvinus these cells are all filled with protoplasm, and from the facility with which the walls swell under the influence of strong sulphuric acid, the tissue presents one of the best opportunities for observing the continuity of protoplasm. The bast, as a whole, is probably to be regarded as one of the most important mechanical elements present.

From what has previously been stated with reference to the sectional outline of the pulvinus and its included vascular structure, it will be seen that the latter is not concentric with the former, and that the minor axis, which passes transversely through the true structural centre, lies considerably above the centre of the section, and since this is a constant feature of the pulvinus, it will be seen that the lower half of the transverse section and the lower side of the pulvinus always exceed the upper half or side. The relations of parts in these respects were determined by making an outline drawing of all

the parts by means of the camera, under an amplification of 20 diameters. A line representing the minor axis was then passed transversely through the true centre, and all tissues lying above and below measured by means of a planimeter. The results were as follows:—

	Upper Side.	Lower Side.
Pith	1.50 Sq. cm.	1.50 Sq. cm.
Wood and Bast	16.50 " "	23.00 " "
Parenchyma of Pulvinus	80.65 " "	171.25 " "

From this it appears that, leaving the pith altogether out of consideration, as of no mechanical importance, whatever tension is produced in the vascular bundles, as opposed to the tension in the surrounding pulvinus, must be developed above and below the true centre in the proportion of 1 : 1.39. Since the vascular elements are of the nature of permanent structure, their tension in relation to surrounding parts must be positive, and any general release of tension must result in a contraction of the organ through the vascular region. It therefore follows that this contraction must be stronger along the lower side of the pulvinus in the ratio given, and hence a tendency to curvature of the pulvinus downward. This, though slight, may often be noticed.

The tension in the tissue of the pulvinus, as opposed to that of the vascular structure, is developed above and below the true centre in the proportion of 1 : 2.12. The parenchyma tissue of the pulvinus is that capable of the greatest and most continued growth, as also that in which the greatest variations of tension must occur through variable turgescence. Its tension, with relation to the vascular structure, must be negative; hence any release of tension must permit contraction of the whole organ, while increase of tension must tend to elongate the pulvinus, and this action will be developed above and below in the ratio given. From this it is obvious that elevation and depression of the leaf, as a whole, depend respectively upon the pulvinus proper and the enclosed vascular structure.

From what has thus far appeared, we are doubtless prepared to gain a true explanation of the large intercellular cavity and its external braces, which occur at the base of the pulvinus. The three braces, of which the central has been seen to be the largest, must doubtless be regarded, first of all, as means of mechanical support through the firmness of their structure; while the pulvinus proper, which still surrounds each, seems to control changes of position to a certain extent, by its variable tension. The depression of the leaf, under any circumstances, however, must cause a much stronger compression of the structure on the under side of the pulvinus, where the flexure occurs, than elsewhere; and this is at once compensated for by the large intercellular cavity, which permits the central brace to bend into it, the leaf thereby hinging chiefly upon the upper side of the pulvinus. This view gains additional weight from the fact that, while very slight curvature may arise through the whole length of the pulvinus, the depression of the leaf is chiefly accomplished by sharp bending at the extreme base of the pulvinus, which thus becomes the true joint or hinge.

Pulvinus of the Leaflet.—The pulvinus of the leaflet bears but little external resemblance to the main pulvinus. It is of uniform width, and extends the entire length of the petiolule, being but slightly flattened along the upper side. The length varies—between leaves just unfolding and in their mature state—from 5.0 mm. to 6.0 mm.,

while for the same period the diameter varies from 1.0 mm. to 1.5 mm. These dimensions are subject to much less variation, as dependent upon conditions of growth, than in the main pulvinus. Externally, each little pulvinus is minutely and somewhat densely pubescent, a character which at once distinguishes it from the large pulvinus. Both the superior and inferior terminations are devoid of lateral ridges or depressions, nor is there any intercellular cavity. In these facts, there appears a very strong argument in support of the supposed mechanical importance of these structural features. The structure, in all its parts is continuous throughout, so that in most respects relating to their grosser anatomy, the larger and smaller pulvini are quite distinct.

In its internal structural features, the epidermis is simple and the cuticle thin. The tissue of the pulvinus is the same as that in the large pulvinus, though not so strongly developed as a whole. (Plate V. Fig. 5.) The important feature of the organ, as a whole, is the peculiar form of aggregation of the tissues and their mutual relations. The transverse section is nearly round, its vertical diameter exceeding its transverse in the ratio of 1 : 1.06. The wood and bast, instead of forming closed zones, are open along the upper side, where the pith blends with the tissue of the surrounding pulvinus. This peculiar arrangement bears an important relation to the flexibility of the petiolule as a whole, and corresponds with the fact that curvatures of this organ are downward and not upward. Determining the distribution of similar tissues, as in the previous case, with reference to the true centre, we find the following :—

	Upper Side.	Lower Side.
Wood and Bast	1.9 Sq. cm.	6.6 Sq. cm.
Parenchyma of Pulvinus	33.8 " "	51.3 " "

Assigning the same function to these tissues in their relations of mutual tension, as in the case of the main pulvinus, it would appear that the influence of the special tissues concerned, in promoting elevation or depression of the leaflet, must be exerted between the upper and the lower side of the pulvinus in the following ratios :—

	Upper.	Lower.
Wood and Bast	1 :	3.47
Parenchyma	1 :	1.52

Comparing these values for those obtained in the previous case, it appears that in the lower side of the pulvinus the vascular elements exert a much stronger influence as a contractile tissue, while the parenchyma exerts a much weaker influence as an erectile tissue. Inharmonious with our previously expressed views as this at first sight appears to be, it really offers no ground of conflict if we bear in mind the relative size of leaf and leaflet, and thus realize the very inferior influence of gravitation upon the latter. The intercellular cavity which appeared in the large pulvinus is, in the smaller organ, replaced by the peculiar development of the vascular structure. The open pith which appears along the upper side permits a greater extension of parts in that region, as the pulvinus curves downward.

During the period when the leaflets are folded, just as they emerge from the bud and for a short time afterward, they manifest no nyctitropic movement. During that

period, all the vascular elements are in a nascent state (Plate V. Fig. 6 A). As soon, however, as the leaflets unfold and movement begins, the various vascular elements are found to have become strongly developed (Fig. 6 B), and from that time onward they continue to increase in their character as permanent structure. It thus appears true that no movement can occur until the woody tissue reaches a certain stage of maturity.

SENSITIVENESS.—The leaves of Robinia are not sensitive in any marked degree. Incisions and other strong irritations of the pulvinus have, with us, produced no effect. Simple irritations, such as would produce an immediate effect in the tendril of Cucurbita unless very much prolonged, are also without effect, and response appears to be gained from nothing less violent than percussion. Several determinations of the effect of percussion were made. In each case the base of the leaf just above the pulvinus was given a short, sharp blow with a pencil. The following results were obtained (in each case the degrees given represent the depression of the leaflets two minutes after percussion) :—

(*a*) 10.05 A.M.—No. 1=87°. No. 2=87°. No. 3=60°.—Recuperation complete at 10.25.—Time required=20 m.—Plant in shade.

(*b*) 10.12 A.M.—No. 1=87°. No. 2=50°.—Recuperation complete at 10.30.—Time required=18 m.—Plant in shade.

(*c*) 10.17 A.M.—No. 1=50°. No. 2=45°.—Recuperation complete at 10.30.—Time required=13 m.—Plant in sun.

(*d*) 10.20 A.M.—No. 1=45°. No. 2=45°-80°.—Recuperation complete at 10.31.—Time required=11 m.—Plant in the sun.

(*e*) 10.32 A.M.—No 1=0°. No. 2=0°. No. 3=50.—Recuperation complete at 10.42.—Time required=10 m.—Plant in the sun.

(*f*) 10.38 A.M.—No. 1=50°. No. 2=45°. No. 3=45°.—Recuperation complete at 10.53.—Time required=15 m.—Plant in the shade.

(*g*) 10.42 A.M,—No. 1=55°. No. 2=45°-50°. No. 3=45°-60°.—Recuperation complete at 10.59.—Time required=17 m.—Plant in the shade.

(*h*) 10.47 A.M.—No. 1=0°. No. 2=0°. No. 3=2°-3°.—Plant in the sun.

In all these observations it was noticed that the basal leaflets, hence those nearest the percussion, responded first and most strongly; also, that the effect of percussion did not appear until fifteen or twenty seconds had elapsed, after which the motion became an accelerating one until the maximum of change was reached; the time for recuperation, as indicated above, thus embraces both depression and subsequent elevation to normal position. In all these cases one fact is conspicuous, viz., the relation of recuperation to direct action of the sunlight. Whenever the plant was in the sun the leaves were much less depressed from percussion, and their recuperation was much more rapid as compared with leaves in the shade.

NYCTITROPISM.—The nyctitropic, or true sleep movement, is that which essentially characterizes the leaves of Robinia. They may also manifest during the day, under the influence of bright sunshine, a paraheliotropic movement, during which the general tendency is for the edges to be turned upward to the sun, as if to check its influence. As Darwin has already pointed out,[1] the object of this movement is totally different from that of sleep movement, and is doubtless designed to lessen the destructive influence of too intense sunlight upon the chlorophyll.

[1] Movements of Plants, 355, 445.

Our observations have been almost wholly confined to the true nyctitropic movement, the principal data of which we have collected in connection with M. Chapman and G. E. Cooley.

Sleep-movement usually begins within half an hour after sunset, though this period appears to become longer as the season advances. In all cases, it has been most conspicuous that leaves at an elevation, e.g. those on the tops of trees, assume the sleep position much sooner than those at a lower level. No general rate of change, however, can be stated for all the leaves, since it is found that the leaflets fall into the nocturnal position at very irregular intervals, some assuming this position very early in the evening, while others remain in their diurnal position until quite late. The sleep-movement is generally completed by 10.30 p.m. From that time on there is no change in position, until the actual awakening occurs, which begins just before dawn. With reference to this, the following extract from our notes will give the general features of the change :—

"At 2 o'clock a.m. the maximum darkness and minimum temperature have just passed, and the older leaves show the first signs of awakening, many of the leaflets being expanded 5° or 10° from their former sleep position. At 3.30 the leaflets have opened to to an angle of 45°, and at 4 o'clock they are well expanded, the most marked change occurring within the latter hour. From an examination of the accompanying table the general conditions throughout the night may be obtained. The temperature was taken from an exposed thermometer, hung at the height of, and among, the plants observed. This will account for the variations of temperature noted in one or two instances :—

Hour.	Temp.	Remarks.
7.30 p.m.	16.00° C.	Leaves closing.
8.00 "	16.50	Sky clear all night.
8.30 "	16.25	
9.00 "	15.25	
9.30 "	15.50	
10.00 "	16.00	
10.30 "	16.25	Leaves all closed.
11.00 "	16.75	
11.30 "	15.00	
12.00 "	14.30	
12.30 a.m.	12.75	
1.00 "	11.25	
1.30 "	11.20	Max. darkness.
2.00 "	12.75	Leaves begin to open.
2.30 "	13.00	
3.00 "	13.50	
3.30 "	13.50	
4.30 "	13.25	Leaves all open.

The leading features of the awakening are, that the process begins at or immediately following the periods of maximum darkness and minimum temperature, and that it is completed before the sun rises above the horizon. As in going to sleep, the first change is

noted in those leaves which are highest, so in the awakening the same fact is conspicuous. Important as these facts are to the general question of nyctitropic movement, we can only introduce them incidentally at this time, since it is not our present purpose to determine the precise influence of external causes upon the processes of growth whereby these changes are effected, but simply to determine the mechanism of movement through the various tissues involved. We are, therefore, more intimately concerned in considering the various changes which occur in the leaf and leaflet during the process of sleeping and waking.

As the period of sleep approaches, the most conspicuous indication is to be found in the change of position which the leaflets assume. From a horizontal or slightly elevated position, they gradually droop, until they assume a position at right angles to their normal diurnal position ; thus, assuming the leaf as a whole to be horizontal, each leaflet becomes vertical. Two important facts are here to be noted, viz., the relation of these changes to gravitation, and the indications they give of the operation of an active force. Whatever the position of the leaf as a whole may be, the leaflets are found to be influenced in certain directions by the action of gravitation upon their mass. Thus, if the leaf as a whole be horizontal, the drooping leaflets will finally assume a position perpendicular to its length. If it be raised or depressed above or below the horizontal, the leaflets no longer hang perpendicular to the leaf—with reference to its length—but fall vertically. Thus each leaflet is seen to turn laterally upon its petiolule as an axis, in direct response to the influence of gravitation upon its mass, and in this respect it is independent of the position of the leaf as a whole. In harmony with this, it will always be found that, in petiolules of a depressed leaf, there is a distinct torsion conforming to the relation which the leaflet bears to its main rachis. In leaves which hang almost vertically from drooping limbs, the leaflets thus often come to lie nearly parallel with the rachis.

When the leaflets fall into the sleep position, there is always a strong tendency for them to pass by the vertical plane passing longitudinally through the leaf; or in other words, the movement of the leaflets, with respect to the width of the leaf, is independent of gravitation. As the sleep movement progresses, the leaflets of each pair hang quite parallel, being separated throughout by a distance of 5 or 8 mm., representing the combined width of the rachis and length of the two petiolules. Soon, however, each leaflet bends in at the tip toward the other, so that they finally touch. This is effected in part by a curvature throughout the entire length of each leaflet, but much more by a continued curvature of the pulvinus of the petiolule, the result being that each tip is carried several millimetres beyond that point which would be determined by gravitation alone. Removing the opposite leaflet of each pair, does not seem to affect the movement of that remaining. In the terminal leaflet, the sleep position is assumed precisely as if it were a lateral leaflet, with the difference that its change of position is much greater, and it is carried much farther past the vertical. Without any regard to the position of the leaf as a whole, the terminal leaflet drops until it forms an acute angle with the rachis on its lower side. If the leaf be horizontal, the terminal leaflet bends several degrees past the vertical. If, however, the leaf be drooping, then the leaflet still establishes the same relation to the rachis, and thus often becomes horizontal or even turns up past the horizontal. In the case of leaves which were hanging vertically, this reflex position of the terminal leaflet was often found to be 10° above the horizontal, or about 100° from the position which would

be established by gravitation alone. These facts, therefore, show that the true sleep movement is not passive, similarly to that previously discussed, but that it is due to an active force, the measure of which is partly expressed in the degree to which it overcomes gravitation.

In assuming the sleep position, each leaflet droops: first, by curvature of the petiolule through its whole length; secondly, by a sharper bending at the junction of petiolule and leaflet; thirdly, by a slight curvature through the entire length of the leaflet itself. In this connection it is important to note that, when leaflets are removed by cutting away at the extreme base of the petiolules, the latter almost immediately curve, the curvature conforming to that which is produced during the normal sleep movement. There is, in all this, a strong indication that the change is due to release of tension in the tissue of the pulvinus.

In the leaf as a whole, there is comparatively little movement. Darwin[1] has shown that there may be an actual elevation during sleep, to the extent of 3° or 4°. Our own observations show, and probably with greater frequency, a depression of the whole leaf to the extent of 35° or 50°. The same change may sometimes be induced by irritation, occasionally in a more marked degree. In all such changes of position, they appear to be accomplished at the extreme base of the pulvinus which thus acts as a hinge. As the leaf drops, the central ridge on the lower side of the pulvinus recedes slightly, the cushion around it becomes somewhat wrinkled, but on the upper side the pulvinus is drawn quite tense and smooth. It is important here, to note the difference between the pulvinus of the leaf and of the leaflet during the sleep movement, as it will be found to be correlated in a most significant manner, to the internal structure in each case.

Conclusion.

The deductions which can reasonably be based upon the foregoing facts, may be briefly stated.

By comparison with Cucurbita and Vitis, the absence of any marked sensitiveness in Robinia, would imply the absence of a tissue in which variation of tension under external irritation is a special function. This we find quite in accord with the presence of collenchyma in the former, its absence in the latter, and the relation which it bears to the sensitiveness of the organ itself. Whatever transmission of impulse there may be, can be readily determined as in the previous cases through the continuity of protoplasm.

In the leaf, the soft tissue of the pulvinus proper is that in which the variations of tension under external influences is determined. Moreover, the fact that this tissue is greater below than above the centre, points to its serving as the true erectile tissue wherever its internal tension is augmented sufficiently—becoming simply passive when its tension is reduced below a certain point. This is a more important factor in the pulvinus of the leaflet than in the large pulvinus, since the changes in the leaflet are greater, and require a relatively greater erectile force. As the pulvinus determines the upward movement, the included fibrous elements determine the downward and reflex movements.

[1] Movements of Plants, 355.

Being in a state of positive tension, any release of tension in the surrounding pulvinus at once permits contraction in the bast. Under irritation, and possibly other influences, this may also be increased by loss of water, as occurs in a more marked degree in the collenchyma of Cucurbita. The direction of bending, as determined by this contraction, depends upon the distribution of the bast in the organ. In the case of the leaflets, we have seen the bast to be so disposed below the axis of the petiolule, that the latter can only curve downward, this being facilitated, moreover, by the vascular structure being open along the upper side. In the main pulvinus, the closed cylinder of vascular structure preserves a condition of rigidity in all parts except at the extreme base, where we find the vascular structure to become branched in such a way as to produce a true joint in connection with an intercellular cavity.

Explanation of Plates.

Plate III.

Figure, half natural size, showing movement of tendril tip. The figure is seen as if the observer were at at the base of the tendril looking toward the tip.

Plate IV.

Fig. 1.—Half section of tendril arm of *Cucurbita pepo* × 66.
- (*a*) Vibrogen.
- (*b*) Collenchyma.
- (*c*) Active parenchyma.
- (*d*) Bast.
- (*e*) Vascular bundles.
- (*f*) Central pith parenchyma.

" 2.—Bast cells × 266.
- A. During active period.
- B. After coiling of tendril.

" 3.—Collenchyma × 266.

" 4.—Continuity of Protoplasm in collenchyma × 266.

" 5.—Vibrogen × 133.

Plate V.

Fig. 1.—Half cross-section of tendril of *Vitis cordifolia*, Michx., × 66.
- *cl.* collenchyma.
- *pr.* parenchyma.
- *w.* wood.
- *p.* pith.

" 2.—*v.* vibrogen tissue × 266.

" 3.—*cl.* collenchyma × 266.

" 4.—wood tissue × 266.
- A. During activity of the tendril.
- B. After cessation of motion.

" 5.—Cross section of smaller pulvinus of leaflet, *Robinia pseudacacia* × 66, showing relation of central vascular structure to the pulvinus tissue.

" 6.—Structure of vascular zone × 266.
- A. Before nyctitropic activity.
- B. During nyctitropic activity.

VII.—*On Certain Borings in Manitoba and the Northwest Territory.*

By GEORGE M. DAWSON.

(Read May 26, 1886.)

In Manitoba and in the Northwest generally, boring operations are likely each year, as settlement advances, to be undertaken with increasing frequency. The generally uniform character of the surface, coupled with the covering of drift deposits over large areas, due to the Glacial Period, renders boring necessary, whenever it is desired to ascertain the character of the underlying rocks. Most of the borings so far carried out have been for the purpose of obtaining water in localities where the surface supply is insufficient or unfit for use on account of dissolved salts. In a number of cases, the object in view has been attained, and it may be specially mentioned that a good supply of water for the City of Winnipeg has been secured, by wells sunk through the alluvium of the valley, at a comparatively moderate depth.

In too many instances, however, the strata passed through in these borings have not been noted with sufficient care to enable satisfactory sections to be given. The great importance attaching to such records, whether for the guidance of future sinkings for coal and lignite, natural gas or brine, and in explorations which may be attempted in search of petroleum, is my excuse for collecting in this paper such facts as I have been able to obtain and for discussing their bearings. Some of the results already arrived at are interesting from an economic point of view, as indicating the development in the near future of important industries; while, as will have been gathered from the remarks already made, all borings effected in Manitoba and the Northwest, the results of which are carefully recorded, possess a special value from a purely geological standpoint.

In addition to the borings now first reported on, and chiefly made by the Canadian Pacific Railway Company, several experimental borings, conducted under the auspices of the Geological Survey, are referred to in this paper. Details of these will be found in the Reports of Progress, as follows:—

Report of Progress, 1873-74, pp. 3, 12; 1874-75, p. 2, boring at Rat Creek, subsequently referred to; 1875-76, p. 281, boring at Carleton. This experimental boring was executed under the supervision of Mr. R. W. Ells, and was carried to a depth of 175 feet without passing through the drift deposits. 1875-76, p. 292, boring at Fort Pelly on the Assiniboine River. After passing through the drift, this boring penetrated the lower portion of the Pierre shales and ended at a depth of 500 feet in marly beds, evidently representing the Niobrara division of the Cretaceous (cf. Report of Progress, 1879-80, p. 1A.)

I.—Boring at Rosenfeld Station.

This station is situated on the South-Western Branch of the Canadian Pacific Railway, about fifteen miles north of the 49th parallel and ten miles west of the Red River, in the alluvial plain of the Red River valley. The boring was conducted by Mr. W. E. Swan, under instructions from the Canadian Pacific Railway Company. Through the kindness of Mr. W. C. Van Horne and Mr. J. M. Egan, I have been enabled to obtain from Mr. Swan, the logs of this and other borings made by him in the Northwest. Samples of the strata passed through in this well had been given by Mr. Swan to Mr. Acton Burrows, of Winnipeg, who was so obliging as to transmit them to Ottawa for my examination. The section given is, therefore, not precisely in the form of Mr. Swan's log, but is based also on my own examination of the materials obtained. The boring was made by means of an ordinary percussion drill, and was carried to a depth of 1,037 feet from the surface. The strong flow of brine met with in this well (a point subsequently referred to) is the most remarkable feature in connection with it.

In the subjoined section, the formations supposed to be represented are indicated in the column to the right:—

	Feet.	
1. Black soil	4	
2. Fine silt or clay	111	
3. Sand and gravel	10	
4. Boulder-clay ("hard-pan.")	12	
5. Boulders	6	
6. Grey shale	62	Maquoketa shales.
7. Limestone	15	
8. Red shale	5	
9. Grey shale	10	
10. Limestone	30	
11. Fine grey sandstone	40	
12. Chalky limestone	30	
13. Red shale	160	
14. Cream-coloured limestone	305	Galena limestone passing below into Trenton.
15. Red shale	75	
16. Soft sandstone	50	St. Peter sandstone.
17. Dark-red shale	50	Lower Magnesian limestone (?)
18. Reddish and greenish shale	25	
19. Bluish and grey shale	20	
20. Red shale	15	
21. "Granite."	2	Laurentian.
Total	1,037	

The soil, forming the first member of the above section, has the usual characters of that of the region, consisting of the underlying silts mingled with vegetable matter. The silts (described in the log as "blue clay") are those of the ancient lake which, about the close of the Glacial Period, occupied Red River valley, and which has been called "Lake Agassiz" by Mr. Upham. The coarser layers are composed of fine angular and subangular grains with formless argillaceous material; the finer become a blackish-grey plastic clay. The specimens secured of the sand and gravel deposit contained no fragments over three-

fourths of an inch in diameter. The gravel is well rounded, and consists of Laurentian and limestone pebbles not dissimilar from those usually found in a corresponding position in other parts of this district. The "hard pan," while evidently representing the boulder-clay, is unusually pale in colour, being apparently largely composed of limestone debris. The thickness of the boulder-clay is also much less than usual. Its microscopic character has already been described, in connection with that of other similar materials of the same age, in a paper presented to the Chicago Academy of Sciences.[1] The predominent mineral constituents which remain, after the finer clayey matter has been washed away, are rather coarse quartz grains, of which nearly one-half are perfectly rounded. Bottle-green fragments of hornblende are moderately abundant, as are also grains of felspar and limestone, but comminuted shaly materials are almost altogether wanting. It also contains a few specimens of foraminifera, which have been derived from some not far distant Cretaceous beds. These include a Textularia of the type of *T. globulosa*, with fragments of Rotalidæ and other forms.

Of the deposit described as "boulders" no specimens were obtained.

The beds underlying these superficial deposits, from No. 6 to No. 13 inclusive, are supposed to represent the Maquoketa shales. Their character is as follows :—

No. 6. This is a moderately firm greyish-green shale, with minute reddish laminæ and some thin films of pyrites parallel to the bedding. It is not calcareous, and under the microscope is found to contain a considerable proportion of partially rounded quartz grains, but no fragments were observed of hornblende or other green or dark minerals usually found in the boulder-clays and other drift deposits.

No. 7. This limestone is cream or buff coloured, and rather coarse. It effervesces freely in cold dilute acid. It is, apparently, easily friable, as the sample received was in the form of coarse sand.

No. 8. A soft shale of general reddish colour, but holding also purplish and greenish layers, and showing under the microscope much subangular grit.

No. 9. Resembles No. 6, and is a rather firm yellowish-grey shale, showing under the microscope a considerable proportion of partly-rounded, somewhat coarse quartz sand in a brownish argillaceous matrix.

No. 10. The specimen of this rock consisted largely of cream-coloured limestone in small fragments, but more than half of it is of coarse quartz sand. This might have been derived from the friction of the boring rods against the upper portion of the sides of the hole, but is unlike any met with in the overlying deposits. It is probably interbedded with the limestone, but no calcareous cement was observed to adhere to the grains. The sample included one small piece (about half an inch long) of coarsely granular whitish gypsum.

No. 11. This is a fine-grained calcareous sandstone or sandy shale, rather hard, and noticeably finer and more siliceous than No. 6. The only organic traces met with in these rocks were found in this layer. They consist of thin, dark-coloured corneous-looking laminæ seen on the surfaces of small fragments. Portions which were removed, and microscopically examined, showed occasional regularly disposed systems of bifurcating canals, closely resembling some of those figured and described by Bowerbank as occur-

[1] Bulletin, Chic. Acad. Sci., No. 6. Vol. i, 1885.

ring in the epidermis (*periostracum*) of *Solen vagina*. (Trans. Micro. Soc., London, 1844, Vol. I. p. 123.) They probably represent either the epidermis of some mollusc or portions of the test of a small crustacean.

No. 12. This material (described as "chalk" in the original log) consisted chiefly of coarse and fine calcareous granules, the latter under the microscope appearing rounded, and being probably concretionary in character. Small selenite crystals are rather abundant. The colour of the mass varies from white to pale greenish and reddish grey.

No. 13 is a soft, reddish shale, slightly calcareous, with small white spots of gypsum. The matrix also contains much subangular quartz, in grains which are very irregular in size, some being quite coarse.

Layer No. 14 (over 300 feet in thickness), which is supposed to be equivalent to the Galena limestone, and possibly at the base to include a portion of the Trenton, was represented by several specimens. It is cream or buff coloured, apparently uniform in character, generally free from detrital matter, and effervesces freely in cold dilute acid. It is rather coarsely granular in texture.

No. 15 is a reddish shale, scarcely calcareous, and with much quartz in subangular grains. It resembles No. 13, and contains small crystals of selenite.

No. 16 was represented by four specimens, of which those from the upper part of the bed were pale reddish in tint; these from the lower part nearly colorless transparent quartz sand. The reddish coloration is very probably due to admixture of small portions of the overlying red shale. The sand is coarse, clean, uncemented, with grains all beautifully rounded and polished by attrition, in a manner suggesting the action of wind rather than of water, and precisely resembling that of the St. Peter sandstone as seen near St. Paul, Minnesota.

No. 17 is a soft, non-calcareous, dark brownish-red shale with, in some places, very thin greenish-grey interlaminations. Under the microscope, it is found to include much fine and pretty well rounded quartz sand.

No. 18. A non-calcareous shale similar to last, but about one third of the fragments greenish, while portions of the remainder are a very dark purplish-red.

No. 19 is a bluish-grey, fine-grained shale or argillite, scarcely laminated and very slightly calcareous. A small concretionary pellet of gypsum was included with the sample, and was probably derived from the shale.

No. 20. This is a soft, dark reddish material, rather like a clay than a shale. It does not effervesce with acid, and, in addition to much fine and some coarse quartz sand, it contains half-rounded quartzose fragments as large as grains of wheat.

No. 21. The rock met with at the bottom of the boring, and said to have been penetrated for two feet, is described as granite. The specimens received, however, consisted almost entirely of "cavings" from the upper parts of the hole, mingled with which were some small angular flakes of granite or gneiss, chiefly composed of quartz and red felspar in rather small crystals.

While in the complete absence of palæontological evidence and of neighbouring outcrops to which reference may be made, the stratigraphical position of the beds passed through in this boring may be considered somewhat doubtful. I am, on careful consideration, disposed to believe that they represent that portion of the Cambro-Silurian between the Maquoketa shales (Cincinnati or Hudson Rivers) and the Lower Magnesian limestone

(Calciferous). The following are the grounds on which this correlation of the beds is made :—

Beds 6 to 13 inclusive are, as already stated, supposed to represent those named the "Maquoketa shales" by Dr. White in Iowa. In Iowa, the beds so named are about 75 feet in thickness, and consist of bluish and brownish shales with calcareous layers, which sometimes form a considerable part of the whole. In Wisconsin, the Maquoketa beds average about 200 feet in thickness and are composed of grey, green, blue, red, purple, buff and brown shales with thin limestones. These beds are also known in Minnesota, which, being much nearer to the locality now in question, would afford a better term of comparison, but there appears to be, unfortunately, an absence of complete sections. At Stony Mountain, however, fifty-eight miles north, in Manitoba, rocks determined by Mr. Whiteaves, on the evidence of fossils, to be of Hudson River age, occur, and so far as the section is there apparent, it corresponds pretty closely in general character with that in the Rosenfeld well. The beds at this place are as follows, in descending order:[1]—

	Feet.
1. Brownish-grey dolomitic limestone	40
2. Reddish-grey limestones, clayey partings	10
(Small gap in section.)	—
3. Limestone like No. 1	20
4. " in thin beds	4
5. "	2
6. Limestone, thin and broken	6
7. Yellowish rock	8
8. Reddish shales	10
9. Yellow and red shales	60
Total	160

These evidently nearly resemble those numbered 10 to 13 in the Rosenfeld boring.

The limestone numbered 14 in the section at Rosenfeld is supposed to represent the Galena limestone of the west, which it resembles in character. It probably, however, as already stated, may include layers at the base equivalent to the Trenton, to which latter formation the red shale, 75 feet in thickness, next underlying in the section, must be assigned. The Galena limestone of the west, which is nearly equivalent to the Utica of the New York series, is about 180 feet thick in Minnesota; 250 feet thick in Wisconsin; and from 100 to 250 feet thick in Iowa. The Trenton, in Minnesota, consists of flaggy limestones, with interbedded greenish shales, and is nearly 160 feet in thickness. In Iowa it consists of clayey shales and shaly and compact limestone, 200 feet in thickness. The reddish colours of the Rosenfeld shales and their apparently more complete separation from the limestone and want of interlamination with it, constitute the chief point of dissimilarity. The massive buff limestones of Selkirk and Stone Fort in Manitoba, resemble the Rosenfeld bed in character, and are known by the evidence of fossils to represent the Galena.

The sandstone, or rather unconsolidated sand-bed, which is the next underlying member of the section, has already been described as precisely resembling the typical St.

[1] From paper by J. H. Panton, Manitoba Hist. and Lit. Soc., Trans. 15, Session 1884-85.

Peter sandstones. Its thickness (50 feet) is somewhat less than that assigned to the same bed to the south. This in Minnesota is stated as 125 feet; in Iowa, 80 feet, and in Wisconsin, from 80 to 100 feet. The St. Peter sandstone has not elsewhere been recognized in Manitoba, and there is, therefore, no local term of comparison for this and the underlying Cambro-Silurian beds.

If the stratigraphical positions assigned to the foregoing beds are correct, beds 17 to 20 both inclusive, with an aggregate thickness of 110 feet, must occupy the position of the Lower Magnesian limestone, equivalent in age to the Calciferous of the New York section. This limestone in Iowa and Wisconsin, has a thickness of 65 to 250 feet. In Minnesota it is described as a cream-colored magnesian rock, but toward the top it is frequently sandy, and with beds of greenish shale. At Rosenfeld no limestone occurs, and we, apparently, have instead a littoral formation directly overlying the subjacent Laurentian, and marking the limit at this place of the Lower Magnesian Sea.

No sufficient supply of fresh water was met with in this well, but instead, a flow of brine was encountered. A small flow of brine was found below the limestone numbered 10 (30 feet in thickness), a second flow beneath the heavy limestone bed (No. 14) and when the St. Peter sandstone (No. 16) was reached, the supply increased four-fold, and formed a flowing well, which has, I believe, continued to give issue to large quantities of salt water ever since. Mr. Swan states that it rose in a pipe to a height of 18 feet above the surface of the ground, which is three feet below the level of the railway grade.

The most interesting feature in this connection is the great geological age of the rocks from which this brine comes. It appears not improbable that the shoaling of the Cambro-Silurian sea evidenced by the widespread littoral deposit known as the St. Peter sandstone resulted in the enclosure of salt lagoons in this portion of the interior basin, while it merely produced an increased land area further south in Iowa and Wisconsin.

The brine is of a quality well adapted for the manufacture of salt, and might be concentrated by solar evaporation and finally evaporated in pans. It has been examined and is reported on by Mr. G. C. Hoffmann, in the Annual Report of the Geological Survey for 1885 (p. 13 M). Mr. Hoffmann states that it contains but a small amount of deleterious salts, and gives the following as its composition for 1,000 parts by weight:—

Chloride of Potassium	0.4179
" Sodium	36.4971
" Calcium	0.3982
" Magnesium	1.7225
Sulphate of Lime	4.1511
Borate of Soda	traces.
Carbonate of Lime	0.0777
" Iron	traces.
Bromide of Magnesium	undt.
Iodide of Magnesium	undt.
Silica	0.0126

Another point of interest brought out by this boring is the comparatively thin covering of Palæozoic rocks which here overlaps the Archæan, and the very gradually shelving character of the surface of the latter westward. The slope of this surface, in a westward direction, from the last low Archæan exposures on the Lake of the Woods being

(on the supposition that it is uniform) not more than 11·5 feet to the mile. The Archæan surface at Rosenfeld is 265 feet below the present sea-level, that in the southern part of the Lake of the Woods is 1,060 feet above the same datum. A further remarkable fact in this connection is afforded by the boring conducted at Rat Creek in 1874, by the Geological Survey, details of which will be found in the Report for 1874-75 (p. 3). This place is about seventy miles north-west of Rosenfeld. Here, after penetrating the superficial deposits, the surface of a buff Silurian or Devonian limestone was reached at about 103 feet below the prairie-level. This limestone proved to be only forty-two feet in thickness, and beneath it a fine-grained grey crystalline rock (apparently a quartzite) was bored into for a depth of about eighty feet. This rock evidently belongs to the Archæan, and is either Laurentian or Huronian. The Archæan surface at this place must be nearly 700 feet above the present sea-level. The relative elevation of the Archæan surface at these three points (Rosenfeld, Lake of the Woods and Rat Creek) would indicate a direction of about W.N.W. by E.S.E., as that of a level line drawn upon it in this part of its extent.

II.—Boring at Solsgirth.

This is a station on the Manitoba and Northwestern Railway, in the north half of section 30, township 17, range 25, west of 1st principal meridian, elevation 1,757 feet. I am indebted for particulars concerning it to Mr. Reginald Baker, General Superintendant of the railway. The information was obtained partly from an excavated well and partly from a boring. The notes were accompanied by a suite of specimens, which has been carefully examined. The section is as follows:—

	Feet.
1. Loam	2
2. Hard blue clay and gravel	42
3. Hard blue clay and stones	10
4. Hard yellow " hard pan."	12
5. Softer bluish clay	16
6. " " "	74
7. Layer of sand [with water]	—
8. Blue clay with stones	136
9. Grey clay (shale?)	68
Total	360

The specimens received show the material to have been a hard grey boulder-clay in which small rounded fragments of fine grey Cretaceous shale, and of the white limestones of the Manitoba lake-region, are abundant. No. 9, of which one small specimen only was received, appears to be a grey, gritty, Cretaceous shale, resembling some parts of the Pierre shales, but it is not absolutely certain that it may not represent a laminated clay belonging to the drift. Excluding this lowest layer, however, the thickness of the glacial deposits is here rather remarkable, being no less than 292 feet.

From 76 feet below the surface, in the boulder-clay, a broken fragment, 1½ inches in diameter, of pale-grey, fine-grained, Cretaceous argillite, was brought up. Fragments of wood, for the most part soft and decayed, but not otherwise much changed, except from

the considerable compression they have suffered, were obtained from depths of 95, 107, 120 and 135 feet from the surface. They would appear to have been imbedded in the boulder-clay, and not to have occurred in any well marked interglacial deposit. Part of a specimen of wood from a depth of 135 feet was so well preserved as to admit of its identification under the microscope as a Taxus It is indistinguishable in structure from the wood of *Taxus baccata.* The supply of water met with in bed No. 7 rose to within 56 feet of the surface, in the hole, but was not copious.

III.—Boring at Grenfel Station.

This station is 279 miles west of Winnipeg, on the line of the Canadian Pacific Railway, and lies between the Weed Hills on the south, and Qu'Appelle River on the north, at an elevation of 1,933 feet above sea-level. The boring is 200 feet in depth, and is evidently entirely in the drift deposits. It is not stated whether a sufficient supply of water was obtained. The section is as follows:—

	Feet.
1. Loam	2
2. Yellow clay	18
3. Blue clay	75
4. Gravel and sand	5
5. Blue clay	90
6. Gravel and sand	10
Total	200

IV.—Boring at McLean Station.

This boring is on the line of the Canadian Pacific Railway, McLean being the next station west of Qu'Appelle Station, and twenty-four miles east of Regina. The well was begun at the same level with the adjoining track, or 2,248 feet above the sea-level. It was carried to a depth of 495 feet and then abandoned. The section, as given by Mr. W. E. Swan, is as follows:—

	Feet.
1. Black loam	1
2. Yellow clay	25
3. Blue clay	65
4. Gravel and sand	12
5. Blue clay and sand	85
6. Gravel and sand	10
7. Blue clay and gravel	98
8. Sand and gravel	52
9. Boulders	6
10. Blue clay and gravel	96
11. Gravel and sand	35
12. Boulders	5
13. Clay and sand	5
Total	495

No specimens from this boring were received, but it is pretty evident that it did not penetrate to the bottom of the boulder-clay and other drift deposits. The upper layers, 1 to 3 inclusive, aggregating 91 feet in thickness, are apparently the fine silty deposits, which form a mantle over an extensive region on both sides of Regina, and represent the sediments of a large later glacial lake. The remaining beds are referable, with little doubt, to the boulder-clay and associated deposits. These are here remarkably thick and must fill a deep pre-glacial hollow. It is instructive to compare this boring with two of those executed by Dr. Selwyn, in 1880, in the vicinity of the Souris River, and about 120 and 140 miles respectively south-east of McLean. The material passed through in the borings is very similar, consisting of alternating clays, gravels and sands. These borings are described in the Report of Progress of the Geological Survey for 1879-80, (pp. 8A to 10A). The first was on the Souris Plain, at a point west 10° south, from the mouth of Moose Mountain Creek, the surface being about 1,590 feet above sea-level, and the depth 155 feet. The second, 700 yards east of where the old Boundary Commission trail crosses North Antler Creek, at an estimated elevation of 1,595 feet, and was also 155 feet in depth. Neither penetrated to the bottom of the drift deposits, and though not nearly so deep as the well at McLean, the contrast between the depth of drift met with in them, and the shallow covering of superficial deposits found a short distance further west in the Souris region is sufficiently marked, and similar to that existing between the boring at McLean and that at Belle Plaine Station. This, with the trend of the water-courses in this region of the plains and that of the escarpment of the Missouri Côteau, would appear to indicate a wide and deep pre-glacial hollow, with a north-west and south-east direction which, though partly filled with drift deposits, has not been entirely obliterated by them, and still makes its influence apparent in the ruling surface features. It may probably have been occupied by a river or system of streams in pre-glacial times, though the probability of subsequent changes in relative level in the Northwest, leaves it uncertain in which direction the waters discharged.

Neither of the borings made by Dr. Selwyn, yielded much water, and the probable inference is, that the permeable layers included in the drift deposits, are not continuous, but rather lenticular in character, and that no important source of water is to be found in these deposits in this belt of country. It would appear, however, by no means improbable, that a more abundant supply of water and, possibly, flowing wells might be obtained by sinking to the bottom of the glacial deposits. The pre-glacial depression is likely to have gravelly or sandy layers still flooring it, which might be expected in such a position, to be charged with water.

V.—Wells at Regina.

In the vicinity of Regina, several borings have been made for water. The only one of these of which I have been able to obtain a description is one sunk by the Northwest Mounted Police, near their barracks, and for this I am indebted to Mr. A. L. Perry. It attained a depth of about 100 feet only, and is evidently entirely in alluvial and drift deposits. Water in limited quantities was obtained in layers 5 and 9, amounting, at the date at which Mr. Perry wrote (the spring of 1883) to about one barrel in three minutes. The water rose to within twenty feet of the surface.

The section is as follows :—

	Feet.
1. Clayey soil	3
2. Very dark, sticky clay	27
3. Sand, with small pebbles	10
4. Black, sticky clay	13
5. Sand, red to black	18
6. Black clay	10
7. Sand, dark, similar to No. 5	4
8. Reddish clay, with small pebbles	13
9. Sand, dark and fine	—
Total	98

VI.—Boring at Belle Plaine Station.

Belle Plaine Station is twenty-four miles west of Regina and forty-eight west of McLean, at an elevation of 1,877 feet. The boring was begun at a point three feet below the railway grade, and carried to a depth of 1,551 feet. Two specimens of the material from the lower part of the hole were sent to me by Mr. Swan, but not having had a suite of specimens from the various levels, I am able to give only the actual log, as follows :—

	Feet.	
1. Dark clay loam	3	94
2. Yellow clay	11	
3. Blue clay	80	
4. Blue shale	150	800
5. Black shale	75	
6. Grey shale	125	
7. Brown limestone	6	
8. Grey shale	444	
9. Reddish sand rock	20	657
10. Grey shale	190	
11. Hard white sand rock	2	
12. Grey shale, with thin layers of sand rock	200	
13. Grey, soft shale	175	
14. Black shale	70	
Total	1,551	

In this boring, Nos. 1, 2 and 3 are doubtless referable to the superficial deposits, but appear rather to represent the fine lake sediment before alluded to as covering the surface in this region than the boulder-clay, though part of layer 3 may be boulder-clay. Layers 4 and 5, with little doubt, represent the Pierre shales, which might, on other grounds, be expected to underlie this part of the country. It appears to me, indeed, highly probable that all the beds down to and including No. 8 are referable to the Pierre shales, and that No. 7, which Mr. Swan believed to be a boulder, may have been one of the large calcareous nodules frequently found in that formation. If this be so the Pierre would here have been passed through for a depth of 800 feet, which elsewhere in the Northwest is about its full thickness.

Numbers 9 to 13, inclusive, with a total thickness of 657 feet, evidently on either

hypothesis, represent beds below the Pierre, referable to the Belly River series or to the Niobrara. Not having at present any accurate knowledge of the character of the formation underlying the Pierre in this district, and in the unfortunate absence of specimens, we are are unable exactly to correlate it. A small specimen from layer 13 consists of buff or pale-grey shale, with small calcareous veins or intercalations. The lowest bed, of which also a specimen is to hand, was penetrated for a thickness of 70 feet, and is a dark, soft shale, or shaly clay, nearly black in colour, and quite plastic when wet. Under the microscope this material is found, besides flocculent argillaceous matter, to contain a considerable proportion of very fine, rather angular, quartz sand of uniform grain. It is not improbable that this represents the highest part of the Benton shales. Mr. Swan notes that no loose sand or gravel was met with in this well. In the sandstone No. 9, a flow of salt water was encountered. This is not described as being a brine, and may probably have been contaminated with sulphates, like most of the waters flowing from the Cretaceous rocks of the West. A small quantity of gas was met with under layer No. 11, but its nature is not stated.

VII.—Boring at Langevin Station.

This place is on the line of the Canadian Pacific Railway, thirty-five miles west of Medicine Hat, at an elevation of 2,471 feet above sea-level. No natural exposures occur in the immediate vicinity or nearer than those on the Bow River, but from a consideration of these, the relative elevations and other circumstances, the rocks underlying the drift at this place have been mapped[1] as those of the Belly River series, and are probably near the summit of the lower or yellowish and banded portion of this series. The boring would appear in fact to be near the summit of a wide, diffuse anticlinal which, with a general north-east and south-west direction, is here crossed by the line of railway. A depth of 1,400 feet was reached, and, as the lower rocks penetrated must belong to an horizon below that of any seen at the surface in the entire district, a good section would be of exceptional interest. Unfortunately, specimens of the rocks passed through were not preserved. Two borings were actually made, the first having been put down 1,155 feet in 1883, when it was abandoned in consequence of the ignition of a heavy flow of combustible gas, which resulted in the destruction of the derrick, etc., at the surface. In boring the second hole, the gas from the first was used to fire the boiler of the engine. The two wells were sunk by different men, and perhaps partly on account of carelessness in keeping the log, but largely, no doubt, from difference of nomenclature used in describing the materials, the records do not agree as closely as might be expected. It is often very difficult, even in natural exposures of the Belly River rocks, to decide, in measuring a section, where to draw the line between different layers—a circumstance arising from their close resemblance in texture and the blending in colours of one bed with another. It is therefore not remarkable that those in charge of the borings have differed so much in their nomenclature and the thickness assigned to the various strata. The section here given is that met with in the first hole, as obtained by Mr. R. G. McConnell of the Geological Survey, who visited Langevin spe-

[1] See geological map accompanying Report C, Report of Progress Geol. Survey, 1882-84.

cially in December, 1883, a short time before the accident above alluded to occurred. The terms employed are chiefly those of the borers' log, though in a few cases, where Mr. McConnell was able to ascertain accurately the nature of the material, it is described. The section is further supplemented by notes which I was so fortunate as to obtain from Mr. W. A. Simpson, who was foreman in charge of the second boring. He was able to give me a description of the general colours of the beds passed through, which affords an important clue in endeavouring to correlate them with the known Cretaceous deposits of the Northwest.

Taking all the facts into consideration, I am inclined to think that we have, first, 88 feet of drift deposits, with, underlying them, about 223 feet of the lower part of the Belly River series, the remaining 1,099 feet consisting of the "Lower Dark shales" of my Report, but passing (as already stated) at the bottom into beds probably lower than any naturally exposed in the region, with the possible exception of those seen in the upturned strata surrounding the Sweet Grass Hills. I am uncertain whether to regard the upper part of the "Lower Dark shales" as constituting a basal portion of the Pierre separated by the Belly River series from the upper part of the Pierre, or as representing the lower part of the Niobrara, and passing below into the Benton. In either case, the lower beds met with in the boring are probably equivalent to the Benton, and some of those found in the last 400 feet of the boring closely resemble, in several characters, beds seen south of the Rocky Spring Ridge in northern Montana, while the beds above these, up to about the 900 feet level, compare closely with those in the escarpment of the same ridge, though they do not include the heavy sandstone bed there met with.[2]

The wells at this place did not yield any sufficient quantity of good water, though small flows were met with at several levels. They have, however, demonstrated the very important fact that a large supply of natural combustible gas exists in this district, at depths of 900 feet and over, in the sandy layers of the "Lower Dark shales." In consequence of the generally horizontal position and widespread uniformity in character of the rocks, it is probable that a similar supply will be met with over a great area of this part of the Northwest, and that it may become in the near future a factor of economic importance. The gas is doubtless derived from the decomposition of the organic matter of the dark carbonaceous shales occurring in the section. Mr. J. M. Egan, in a letter of late date (June 11, 1886), informs me that the flow of gas from this well has continued since without noticeable decrease.

It is unfortunate, for several reasons, that the boring at Langevin was not carried still deeper. Reasoning from analogy with other parts of the Western Territory, one would expect to meet with the Dakota sandstones or basal formation of the Cretaceous of the region at no great depth below that actually attained, and in these it is not improbable that a good supply of water might be found. There is, also, probably on the line of the railway no better place in which, by penetrating the Cretaceous series, to ascertain whether it is underlain by Devonian rocks like those of the Athabasca region, and whether these maintain their petroleum-bearing character so far south. The anticlinal structure already alluded to must, in the absence of contrary evidence, be assumed to

[1] Report of Progress Geological Survey, 1882-84.

[2] See Report of Progress Geological Survey, 1882-84, p. 42 c.

indicate that the covering of Cretaceous rocks is here thinner than in other parts of the region traversed by the railway line. The purely scientific interest attaching to the section, which a continuation of the boring of the lowest beds of the Cretaceous should yield, has already been adverted to. The section in this well, as ascertained in the manner above described, is as follows:—

Depth from Surface. Feet.		Description of Beds.	Thickness of Bed. Feet.	
		Clay loam	30	Probably drift deposits.
37		Quicksand	7	
49		Clay	12	
59		Quicksand	10	
68		Clay and sand	9	
75		Quicksand	7	
83		Clays	8	
88		Quicksand	5	
104	General grey and pale tints, according to Mr. W. A. Simpson.	Sandstone	16	Probably lower part of Belly River series.
113		Soapstone (grey, fine-grained clay)	9	
118		Lime rock (fine calcareous sandstone) [small supply of water]	5	
126		Hard pan (dark shale)	8	
133		Coarse sand	7	
193		Soapstone (greyish clay)	60	
200		Lime rock (fine calcareous sandstone)	7	
209		Sandstone	9	
		Small coal seam	—	
227		Soapstone	18	
232		Sandstone	5	
271		White clay	39	
322		Soapstone	50	
327		Lime rock	5	
464	Beds generally shales of dark to black tints.	Loose shaly soapstone	137	Probably "Lower Dark Shales" of Report 1882-84 passing down into Benton (?)
469		Brownish ferruginous clay	5	
474		Dark lime rock	5	
463		Small coal seam	—	
524		Soapstone	50	
531		Gravel [small supply of water]	7	
537		Sandstone	6	
541		Lime rock	4	
548		Sandstone	7	
558		Hard pan (dark shale)	10	
593		Clays	35	
943		Loose shaly soapstone (fine grey clay)	350	
951	Generally grey tints. One bed of very black shale about 30 thick at 1,000 Fragment of a Baculite from about here.	Lime rock (fine calcareous sandstone)	8	
1,041		Hard soapstone	90	
1,061		Sand and soapstone, with bands of hard-pan and supply of gas	20	
1,111		Sandstone, with streaks of hard gravel	50	
1,151	Generally dark to black tints.	Gravel and clay	40	
1,155		Hard lime. Great flow of gas	5	
1,426		Shales and "lime rock," (probably calcareous limestone) with layers of very dark, soft shale in second hole, to bottom	271	
		Total	1,426	

VIII.—Boring at Cassill's (8th Siding)

This station on the Canadian Pacific Railway is thirty-eight miles west of Langevin, at an elevation of 2,493 feet, or only 22 feet above Langevin, and here, as at that place, two holes were bored. Mr. R. G. McConnell obtained a section of the first to a depth of 700 feet in 1883. The second, put down under the superintendence of Mr. W. E. Swan, was carried to a depth of 1,000 feet. No specimens from either were examined, and as the names used to denote the strata, as obtained from the workmen, are very perplexing, and, moreover, as this section agrees very poorly with that furnished by Mr. Swan, I have adopted the latter, which is as follows (the boring was begun one foot below the level of the railway grade):—

	Feet.
1. Dark clay loam	2
2. Yellow clay	10
3. Blue clay	40
4. Blue shale	110
5. Grey shale	38
6. Drab sand rock	3
7. Blue shale	85
8. Brown shale	6
9. Coal	2
10. Grey shale	134
11. Brown sand rock	3
12. Black shale	257
13. Grey shale	135
14. Brown sand rock	5
15. Blue shale	85
16. Grey sandy shale	40
17. Grey shale	45
Total	1,000

Feeling that some uncertainty may attach to the above section, I do not propose to discuss it in detail. It may be sufficient to state that the first three beds are supposed to represent the drift deposits with a total thickness of 52 feet. Layers 4 to 8 inclusive, with a thickness of 142 feet, appear to represent the lower part of the Pierre, and correspond very well with its known character on the adjacent portion of the Bow River. The coal (No. 9) stated to be 2 feet in thickness, is given as 3 feet in the first-mentioned section and placed about 50 feet nearer the surface. It represents, with little doubt, the Grassy Island seam which, fourteen miles distant on the Bow River, is 4 feet 6 inches in thickness. The underlying beds, with a thickness of 706 feet, are supposed to represent the Belly River series though the great development of "black shale" represented by No. 12 is anomalous.

In layer 6, a small supply of water was met with, and in layer 14 a rather copious flow of combustible gas, which has since continued without perceptible diminution.

IX.—Boring at Gleichen Station (14th Siding).

This station is fifty-two miles west of the last, at an elevation of 2,926 feet above sea-level. It is known to be in the centre of a large area of Laramie rocks, which has a

general synclinal form. The section given was obtained by Mr. McConnell from the record kept during the work; but, as no specimens were examined, the precise meaning of some of the terms employed is rather doubtful. It is as follows:—

	Feet.
1. Sand and clay	8
2. Quicksand	20
3. Blue clay, with gravel and boulders	39
4. Black sand	11
5. Blue clays	22
6. Cement gravel	15
7. Soapstone	40
8. White sand (small flow of water)	5
9. Soapstone	94
10. Black sand	7
11. Loose soapstone	74
12. White lime	3
13. Black shale	40
14. Putty rock	12
15. Lime rock and loose shale	10
16. Soapstone	35
17. Sand rock	9
18. Black shale	20
19. Gravel soapstone (with sand and water)	38
Total	502

Layers 1 to 5 inclusive evidently belong to the drift deposits, and include a considerable thickness of boulder-clay. No. 6 is probably referable to the widespread pre-glacial gravel deposit, which is fully described in the report already several times referred to (Report of Progress Geological Survey, 1882-84).

VIII.—*Illustrations of the Fossil Fishes of the Devonian Rocks of Canada. Part I.*

By J. F. WHITEAVES.

(Read May 27, and revised July 26, 1886.)

Descriptions of species from the Upper Devonian Rocks at Scaumenac Bay, P.Q.

PTERICHTHYS (BOTHRIOLEPIS) CANADENSIS, *Whiteaves.*

Pterichthys (*Bothriolepis*) *Canadensis*, Whiteaves, 1880. American Journal of Science and Arts, Third Series, Vol. XX. p. 132. Reprinted in the Canadian Naturalist, New Series, Vol. X. p. 23.

Bothriolepis Canadensis (Whiteaves), Cope, 1885. American Naturalist, Vol. XIX. p. 290, with woodcut.

Cranial and dorsal shields very slightly elevated; cranial shield moderately arched, most prominent immediately behind the superior opening (the orbital opening of Pander), where it rises into a low, rounded prominence, or broad and obtuse ridge, which is continued with more distinctness and acuteness, but at a slightly lower elevation, along the median line of the dorsal shield.

Outline of the united cranial and dorsal shields broadly elliptical as seen from above, their total length as compared with the maximum breadth being about as five to three.

Cranial shield somewhat semicircular in contour, but much broader than long. The shape and relative position of the various plates of which it and the body shield and dorsal side of the pectorals are composed, are illustrated by an outline diagram on Plate VI (Fig. 1) which represents the whole of the upper surface of the species, as far as known, of the natural size and as viewed from above, with the numbers on the plates corresponding as far as practicable to those in Pander's original restoration of "Pterichthys" under the name *Asterolepis*.[1] Exclusive of the two side plates (A and B) on each of its strongly decurved lateral margins and of those included in the superior or orbital opening (Nos. 6 and 6*a*), the number of plates in the cranial shield appears to be sixteen. Of these, the premedian (No. 4), postmedian (No. 8), nuchal (No. 10), prelaterals (No. 5), marginals (No. 3), and postmarginals (No. 7), to use Prof. Owen's terminology, for the sake of simplicity, are essentially similar to the corresponding plates in Pander's well known restoration of Pterichthys.

On the front margin of the cranial shield, however, three narrow and transversely elongated plates (Nos. 2 and 2*a*) take the place of the single "front terminal or rostral"

[1] In Plate vi. fig. 1 of the monograph entitled "Ueber die Placodermen des Devonischen Systems," published at St. Petersburg in 1857, in which the lateral plates of the cranial, dorsal and ventral shields are numbered on one side only.

plate, shewn in Pander's restoration, which is copied in Prof. Owen's "Palæontology." On each side, too, between the postlateral (No. 9) and the marginal (No. 7, the "os angulare" of Pander) a small and longitudinally narrow plate (No. 9*a*) seems to be intercalated, though this may possibly be part of the postlateral.

Superior or "orbital" opening situated nearly in the centre of the cranial shield, transversely elongated, about twice as broad as long, rounded and a little expanded at both ends and concavely and shallowly constricted in the middle, both above and below. In the centre of this opening, but on a lower level than that of the plates which surround it, there is a plate (No. 6) which is evidently homologous with the "median" plate of Owen and the "os dubium" of Pander. It is somewhat quadrangular in outline, broader than long and broadest behind; its front and side margins are concavely emarginate and its posterior angles appear to be produced into narrow and pointed processes which curve outward. But the space on each side of this median plate is nearly filled up by what appears to be a small, broadly oval plate (No. 6*a*), whose larger axis is nearly at a right angle to that of the whole "orbital" opening. Between the median plate (No 6) and the premedian (No. 4), there is a small and transversely elongated plate (No. 6*b*) of the shape indicated in the diagram. A specimen, in which the front of the head happens to be broken off in a line with the upper margin of the "orbital" opening, shews that the central portion of the front of the little plate, 6*b* (of which an enlarged outline is given on the right hand side of the diagram of the upper surface in Plate VI), is continued downward, at nearly a right angle, as a narrow linear process (*d*) less than a millimetre in breadth and about four mm. in length; after which it widens, at a right angle to the longer axis of the body, into a small and narrowly pentangular expansion about two mm. broad and three in length, which reaches nearly as far as the inner surface of the anterior ventral plates, though these are very much crushed upwards. The deflected portion of this little plate (*d*) is somewhat similar to part of the hyoid apparatus of Clarias as figured by Prof. Huxley,[1] but its outer surface appears to be enamelled and sculptured like that of the dermal plates of the head and trunk, which would hardly be the case if the bones of which it is composed were exclusively internal.

On each of the abruptly deflected lateral margins of the cranium, outside of the postmarginals (No. 7), the marginals (No. 3), and the lateral terminals (No. 2*a*), and in a line with the shoulders of the pectorals, there are two side plates, one in front of the other the anterior of which (A) is very small, and the posterior (B) comparatively large, though rather narrow. The smaller one (A) is distinctly articulated to plate 2*a* as well as to plate B, while the larger one (B) is as distinctly articulated to plates 3 and 7 of the cranial shield and to the upturned and recurved edge of the ventrolateral (No. 19), as well as to plate A. The small and more darkly shaded area marked C, at the outer and posterior angle of side-plate B, on each of the lateral margins, in each case represents that portion of the ventrolateral which is bent up from below.

The posterior margin of the cranial shield is reflected inward in such a way as to form an articulating surface of attachment to the dorsal body shield. The exact contour and other details of this articulating surface, which is exposed only in a rear view of a single specimen of a detached cranial shield, are represented by Fig. 3 of Plate VI.

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[1] Memoirs of the Geological Survey of the United Kingdom. Figures and Descriptions illustrative of British Organic Remains. Decade x. p. 35. fig. 21.

The median angulation of the dorsal body shield is usually most pronounced at or a little in advance of the middle of the dorsomedian plate (No. 12), and, in some specimens, in the posterior part of the post-dorsomedian (No. 14). The shield itself is composed of six large plates, as represented in the diagram. The dorsomedian (No. 12) is hexagonal in outline, and its length and breadth are about equal. The sutures of the two anterior sides of this plate seem to be invariably symmetrical, but those of its posterior sides are frequently not. On its posterior margin, the post-dorsomedian plate (No 14) is obtusely pointed in the centre and truncated somewhat obliquely at each side.

The ventral body shield is nearly flat, but is bent upward and outward at an obtuse angle at the sides, immediately behind and in a line with the insertion of the pectoral spines. The plates of which the ventral surface is composed are represented in outline in the principal figure (Fig. 1) of Plate VII, and they are also numbered to correspond with the numbers in Pander's original restoration of the under surface of Pterichthys. The principal plates of the ventral shield, to quote the words of Hugh Miller, which are strictly applicable to the Canadian species, "are divided by two lines of suture, which run, the one longitudinally down the centre of the body, the other transversely, also through the centre; and they would cut one another at right angles, were there not a lozenge-shaped plate" (No. 16) "inserted at the point where they would otherwise meet."[1] At the posterior end of the ventral shield, the outer margins of the post-ventrolaterals (No. 21) are obliquely and concavely emarginate, while their central portions together form a rather narrowly rounded lobe which projects beyond the terminal end of the post-dorsomedian (No. 14) of the dorsal body shield. The tail opening is not much narrower than the maximum breadth of the united dorsal and ventral body shields; its outline is transversely and narrowly elliptical, but with the ends faintly angulated in the middle. The breadth of the tail-opening is rather more than twice its length along the median line. At the anterior termination of the median suture, a small supplementary plate (No. 17), which corresponds to the "os semilunare" of Pander, is intercalated between the front inner margins of the two ventrolaterals (Nos. 19). This little plate, which is inversely triangular, and rather broader than long, with its front margin straight, is entire and not divided longitudinally down the middle by a suture, as one might be led to infer from Pander's figures. The six plates of the ventral surface which have been described so far are nearly always well preserved and clearly defined; but, in advance of these, there seem to be three others which are very rarely preserved at all, and whose outlines are very difficult to trace. Immediately in front of the central accessory plate (No. 17), there is a small and very thin plate (No. 18) in the median line. It appears to have been somewhat semicircular in outline, though its margins are imperfect in the only specimen in which it can be seen, and it is distinctly strengthened in the middle by a prominent ridge which widens and becomes more prominent anteriorly. Judging by analogies with the Asterolepis of Hugh Miller (but not of Pander) this may have been the hyoid plate. On the under surface of the front margin of the head, there are two terminal lateral plates (No. 15) which, no doubt, correspond to the plates which Pander calls the "lower maxillæ." The outer portions of these plates are bounded by the inner surface of the anterior cranial plates, and their inner margins, which meet above, diverge obliquely and

[1] The Old Red Sandstone, Edinburgh, 1861, 7th ed., p. 74.

convexly outward and backward in such a way as to leave a broadly triangular opening with concave sides, though the posterior and larger part of the opening and a very small portions of the plates themselves are apparently overlapped by the supposed hyoid plate (No. 18), as represented in the diagram on Plate VII. The posterior edge of each of these plates (No. 15) is smooth and rather broad, but the larger and anterior portion is sculptured like the rest of the dermal plates.

The pectoral spines extend a little beyond the centre of the posterior margin of the dorsal shield, but not beyond that of the ventral. They are thin and flattened vertically, so that the outline of a transverse section of one of them above the middle would be very narrowly wedge-shaped, with the thickest end of the wedge inward. They are divided nearly transversely, below the middle, into two segments of very unequal size, by a ball and socket joint, the ball being in the anterior, and the socket in the posterior or terminal segment. The anterior end of each pectoral is also furnished with a ball and socket joint, there being a strongly inflected or excavated cavity in the ventrolateral plate (No. 19) of the ventral shield, to which the anterior end of the spine, which terminates in a rounded protuberance, is articulated The anterior segment, which is much broader and longer than the posterior, is of nearly equal breadth throughout, but the posterior segment is much more slender and narrows somewhat rapidly to an acute point. The outer edge of the whole of the pectorals bears two or more rows of close-set, short and conical, hollow spines, and there is a similar but apparently single row of spines, on their inner edges also. Both segments of the pectorals are divided into numerous plates, of the shapes and numbers indicated in the diagrams on Plates VI and VII, the plates of the anterior segment being large and comparatively few in number, while those of the posterior are smaller and much more numerous.

The whole of the outer surface of the cranial, dorsals and ventral shields, and that of the pectorals, is sculptured in a very complicated way that is difficult to describe, but of which Plates VIII and IX, which are taken from photographs, give a very good idea. This ornamentation consists essentially of closely aggregated and minute shallow pits, surrounded, or partially surrounded, by raised ridges, composed of confluent tubercles, or by rows of tubercles which bend, curve, or divide in almost every direction, and anastomose with or cross each other in such a way as to form a very irregular and minute areolation, or more or less incomplete network. Each of these little pits (which Agassiz has compared to the marks that might be made by pressing the head of a round-headed pin lightly into fresh plaster) is perforated by from one to three minute, vertical and circular canals, which pass through the entire thickness of the test, and which are easily seen by the aid of an ordinary simple lens.

In some large and presumably adult if not aged individuals, in addition to the sutural lines and the ordinary areolation, a widely divaricating impressed line runs forward and outward from the centre of the posterior margin of the cranial shield to a point on each side of the head, a little in advance of the orbital opening. A similar, but rather longer, divaricating impressed line, also runs outward and backward from the centre of the dorsomedian plate to the upper and outer limits of the tail opening.

In a cast of the interior of the head and body shields of a single specimen, there are obscure indications of a pair of flattened, sigmoid, and outwardly directed processes on the anterior margin of the cranial shield, which the writer once thought might be analagous to

the labial appendages indicated by dotted lines on Agassiz's ideal restoration of the genus *Pterichthys*, on Plate VI. Fig. 1, of the Atlas to the "Monographie des Poissons du Vieux Grès Rouge." This explanation of these appearances, however, seems to be no longer tenable, and it is, perhaps, more likely that these supposed labial appendages are merely worn and badly preserved casts of the lateral terminal plates. On each side of the orbital opening, also, in two or three similar casts of the same species, there is a slightly prominent but flattened conical elevation or protuberance, which diverges obliquely forward and outward. These, the writer was at one time disposed to consider, might represent a pair of dermal processes on the outside of the cranial shield, but a more attentive study has led to the conclusion that they are merely depressions of corresponding shape on the interior of the test, which leave little or no traces on its exterior.

No vestiges of the tail or of any of the fins, other than the two pectoral spines, have yet been detected, and no traces of any true bony jaw have yet been recognized. Professor E. D. Cope, who has examined numerous specimens of this species, distinctly states that it has *no* lower jaw, and the writer is of the same opinion.

An average and apparently adult example is of the following dimensions: length of the united cranial and dorsal shields along the median line, about six inches; maximum breadth of the same, three inches and three quarters; length of pectoral spines, not quite five inches. A detached pectoral spine, however, has been collected, which is six inches and three-quarters long, and more or less isolated plates show that the species may have occasionally attained to slightly larger size than that indicated by this pectoral.

A single mould or impression of the ventral surface of a specimen of this species, with one of the pectoral spines in place, was discovered by Mr. R. W. Ells (of the Geological Survey of Canada) in the summer of 1879. The much better specimens upon which the description in the "American Journal of Science and Arts," was based, were collected by Messrs. Ells and T. C. Weston, in the months of June and July of the following year. Since then, including fragments, which are very instructive, between two and three hundred examples of the same species were collected by Mr. A. H. Foord, which, with those already in the Survey collection, have formed the material from which the present description was made.

To quote the words of Prof. Owen:—"The fossil remains of the singular fishes of the extinct order *Placoganoidei* were first discovered about 1813, in formations of the 'old red' or Devonian age in Russia, and are preserved in museums at St. Petersburg and Dorpat. The relations of these specimens to the class of fishes was first announced by Professor Asmuss," in 1840, "and, shortly after, the generic names *Asterolepis* and *Bothriolepis* were invented by Professor Eichwald to express certain modifications of the external surface of portions of the ganoid plates, subsequently recognized as constituting the buckler of the fore-part of these extinct fishes. In September, 1840, Hugh Miller submitted to the Geological section of the British Association at Glasgow the first discovered specimens which afforded a recognizable idea of the form of one of these 'old red' fishes, and for this form Professor Agassiz assigned the generic name *Pterichthys* (*pteron*, a wing, *ichthus*, a fish). Although, therefore, the term *Asterolepis* had been attached to a fragment of the cuirass of this fish a few months previously, yet, as no recognizable generic characters were associated with such name, and as *Asterolepis* has been applied also to other genera—e. g., *Homostius*

and *Heterostius* of Asmuss—the example of British palæontologists will be followed, in retaining the name *Pterichthys*." [1]

In 1857 Dr. Pander published an able and elaborate illustrated monograph on the Placoderms, to which reference has already been made, and his restorations of the dorsal and ventral aspects of "Pterichthys," as it is now generally called, have since been copied in several manuals of geology and palæontology. In this monograph Dr. Pander maintains that *Pterichthys* (Agassiz) and *Bothriolepis* (Eichwald) are both synonyms of *Asterolepis* (Eichwald). As far as the names *Asterolepis* and *Pterichthys* are concerned, the latter has been very generally adopted by palæontologists, for the reasons already stated in Prof. Owen's words. It is still open to question, however, whether the genus *Bothriolepis* is or is not a valid one, and sufficiently distinct from *Pterichthys*. If it is a valid genus, which there are good reasons for supposing it to be, then it has not yet been properly defined. The Canadian species, now under consideration, certainly has the pitted sculpture of Bothriolepis (as pointed out by the writer in 1880), and, if Pander's restoration of Pterichthys be correct, then Bothriolepis would seem to differ from it in several particulars, but more especially in the structure of the mouth organs. Thus, Pander represents Pterichthys as having a lower jaw, beneath which there are maxillary plates which are separated from the cranial shield by a deep cleft. No indications of a true lower jaw have yet been detected in the Canadian species, and the only plates (A and B) in it which might be supposed to represent the inferior maxillæ of Pterichthys are not separated from the cranial shield by a deep cleft, but, on the contrary, are firmly articulated to it. Moreover, the two small oval plates (No. 6 *a*) on each side of the median plate (No. 6) in the orbital cavity (whatever may have been their function) and the singularly deflected little plate (No. 6 *b*) between the median (No. 6) and the premedian (No. 4), in the Canadian species, are not represented at all in any of Pander's restorations of Pterichthys, though they may not have been preserved in any of the specimens to which he had access.

Again, the tails of Scotch examples of Pterichthys are distinctly stated to be covered with small ganoid scales; but not a trace of any such scales has yet been discovered in the many specimens that have been collected of the present species. Prof. Huxley has suggested that Pterichthys may have been a teleostean fish allied to the Siluroids; but if that were the case, we should expect to find some remains of its vertebral column or of other parts of its endoskeleton.

It seems, therefore, highly probable that *Bothriolepis* will prove to be distinct from *Pterichthys* proper, and, if so, then the Canadian species will have to be referred to the former of these two genera.

The Pterichthys (or Bothriolepis) of Scaumenac Bay is so closely allied to the *Bothriolepis ornata* of Eichwald, that it is by no means certain whether the two are specifically distinct or not. Apart from its peculiar sculpture, the specific characters of *B. ornata* are very imperfectly ascertained, the species having been founded exclusively on a few large isolated plates which have been collected from the Devonian rocks of Russia and Scotland. Until more perfect examples of *B. ornata* shall have been described and figured, it will be impossible to institute an accurate comparison between its specific characters

[1] Palæontology, 2nd ed., Edinburgh, 1861, p. 140.

and those of the nearly related Canadian form. The European species seems, however, to have attained to a much larger size than the Canadian, for Agassiz says that some of the plates of *B. ornata* are as much as six inches in length, whereas the largest of the *P. Canadensis* yet found are little more than three inches and a quarter in their maximum diameter.

Acanthodes Mitchelli ? *Egerton.*

Acanthodes Mitchelli, Egerton, 1860. Memoirs of the Geological Survey of the United Kingdom. Figures and Descriptions of British Organic Remains, Decade X. p. 57, Plate VI. Figs. 1 and 2.

Maximum length about an inch and three-quarters; outline subfusiform, but much deeper on the ventral than on the dorsal aspect, the back being apparently almost straight. The deepest part of the body is midway between the pectoral and ventral fins, where the largest specimen (which, however, seems to be abnormally compressed and spread out in the ventral region) measures five lines. Head about one-fifth of the entire length of the body, including the caudal fin. Lateral line distinct. Scales minute, rhomboidal, imbricating and smooth when examined with a lens. Fin spines very lightly recurved, with two deep, longitudinal grooves, the anal being placed slightly in advance of the single dorsal.

Twelve specimens of this little fish were collected by Mr. A. H. Foord in 1881, the smallest of which is half an inch in length and the largest an inch and three-quarters. These seem to agree with Sir Philip Egerton's description and figures of *A. Mitchelli* in so many particulars that they are here referred to that species, though not without much doubt. In the figures which accompany the original description of *A. Mitchelli*, the outer surface of the scales is indeed represented as densely granulose or minutely tuberculated, but Mr. J. Powrie asserts that this representation is erroneous, and that "better specimens prove them to have been perfectly smooth." The largest specimen collected by Mr. Foord is about one-third less in its greatest length than the types of *A. Mitchelli*, though this slight difference in size alone can scarcely be considered as affording a means of specific distinction. Still, the Canadian specimens may prove to be quite distinct from *A. Mitchelli*, and in that case, the writer would venture to suggest for them the name *A. affinis.*

Acanthodes concinnus, N. Sp.

(Plate X. Figs. 1 and 1*a*.)

Length of the largest specimen collected about six inches, greatest height of the same about one inch; outline narrowly fusiform (though all the specimens are so much crushed and distorted that the exact shape is somewhat uncertain), head about one-sixth the total length. Fin spines ornamented with about four longitudinal grooves, rather short and slender in proportion to the size of the body; anal spine situated below and slightly in advance of the dorsal; pectoral spines stout, longer than any of the rest; ventral spines small. Scales rhomboidal, scarcely imbricating, and so minute as to be quite invisible to

the naked eye. When viewed under the microscope, they are seen to be marked with from seven to eight acute and for the most part simple, longitudinal striæ, which, however, occasionally bifurcate. In some specimens, the striæ upon the scales seem to be nearly parallel, but in others they radiate from the posterior angle of the scale. Tail distinctly heterocercal, the upper lobe projecting considerably beyond the lower.

About a dozen specimens of this species and a few fragments were collected by Mr. Foord in 1881. These are all very much distorted, as so often happens to Acanthodians, and the fin spines are in no case all preserved in their normal position, so that it is quite impossible to be sure whether there was originally one dorsal fin or two. In the most perfect examples there seems to be only six fin spines, and if there were two dorsals there ought to be seven. The scales are often very well preserved, but the head is nearly always broken off. The species appears to differ from *A. Mitchelli*, and from all the other Scotch or European forms of the genus, by its much greater size and by the peculiar sculpture of its scales. It was at one time supposed by the writer to be a Diplacanthus allied to the *D. longispinosus* of Agassiz, whose scales are similarly sculptured, but it appears to have had only one dorsal fin.

Phaneropleuron curtum, *Whiteaves.*

Plate X. Figs. 2, 2*a*, *b*, *c*, *d*, *e*.

Phaneropleuron curtum, Whiteaves, 1880. Canadian Naturalist and Geologist, New Series, Vol. X. p. 29.

Maximum length about fifteen inches; greatest height or depth of the same specimen, six inches and a half. All the specimens known to the writer, however, are crushed quite flat laterally, and this, of course, makes the proportionate height or depth look greater than it originally was. General outline, exclusive of the fin rays, varying in different individuals from rather broadly ovate to fusiform, but at the tail end the body always narrowed to a slender and acute point. Head rather small in proportion to the size of the body, about one-fourth or one-fifth the entire length. Cranial plates not very thick, polygonal and more or less elongated longitudinally; very similar in outline to those of Dipterus, as figured by Hugh Miller in the "Footprints of the Creator."[1] Outer surface of the cranial plates apparently smooth to the naked eye, though when examined with a lens, it seems to be minutely pitted and irregularly grooved; inner surface of, at least, some of the cranial plates marked with radiating grooves and ridges, which are plainly visible to the naked eye. Scales thin, cycloid, imbricating, their exposed surfaces concentrically striated and marked also with exceedingly minute radiating lines, which latter are only visible under a somewhat powerful lens. In a single specimen of a small fragment of the body, the lateral line is very distinctly shown.

Dorsal fin apparently single, very long and large, commencing anteriorly in a line with the posterior termination of the head, but little raised as far as the midlength, after which it suddenly becomes strongly elevated and continues so for the rest of its length, and is finally confluent with the upper lobe of the caudal. Height of the posterior por-

[1] 3rd ed., London, 1850, p. 61.

tion of the dorsal not much less than the length of the head. In one specimen there are indications of what looks like a short break or separation between the anterior and posterior portions of the dorsal (or between the two dorsals, if there were two, which is scarcely probable) but this break may be owing to an accidental and abnormal fracture of the fin rays at this point, for in other specimens the two portions appear to be continuous. Anal and caudal fins both extending as far outward from the body as the posterior half of the dorsal does (assuming that there was but one dorsal), and separated at their bases by a very narrow interval. Anal fin narrow and elongated, ventrals acutely lobate and separated from the anal by a space considerably wider than that which intervenes between the anal and caudal. Pectorals broader and longer than the ventrals, the former consisting of a long and acutely pointed scaly lobe, with the fin rays fringing it up to the base.

Both the upper and under jaw are armed with smooth, conical and somewhat compressed teeth. The dental plates of the palate are each furnished with rows of erect, conical teeth, which seem to be arranged in the form of a rectangular patch or quadrature of a circle, very much as they are represented to be in Dipterus. As in the typical and previously only known species of the genus (the *P. Andersoni* of Huxley), the "notochord was persistent throughout the entire length of the vertebral column, while the superior and inferior arches were well developed and thoroughly ossified." The ribs are long, slender and well developed, and, like those of *P. Andersoni*, "stare through the integumentary scales of the fish" in the conspicuous way which suggested the generic name. The neural spines are elongated and slender, narrow in the middle and moderately expanded at each end. The interspinous bones, which support the fin rays of the dorsal surface are shaped very much like the neural spines to which they are adapted, but are a little shorter and straighter, their extremities being truncated at nearly a right angle to their longer axes.

The specimens upon which the original description of this species was based were all collected by Mr. Foord in 1880. Although crushed flat laterally and considerably distorted, four of these specimens are very nearly perfect, but the pectoral and ventral fins are wanting. The rest are mere fragments, but one of them shews the shape and position of one of the ventrals. The largest individual collected in that year is a little more than six inches long and three inches and a quarter in height or depth, while the smallest is about thirty-four lines long and ten high. The variation in the outline of different specimens, and in the proportions which their length bears to their height, is obviously due to the abnormal flattening to which they have been subjected. The smallest examples seem to be the least altered by this lateral pressure, and in these the length is much greater in proportion to the height than it is in the larger ones.

In 1881 Mr. Foord collected a few additional specimens of this species, including one very large individual in which one of the pectorals and both of the ventral fins are preserved in place. These shewed that the species attained to more than twice the size of the largest specimen previously collected, and exhibited very clearly also the character of the teeth in the jaws and palate.

As compared with the *P. Andersoni* of Huxley, from the Old Red Sandstone of Dura Den in Fifeshire (which, as already stated, was the type and only known species of the genus, prior to the year 1880) the *P. curtum*, as its name was intended to imply, appears

to differ principally in its much greater height or depth in proportion to its length. The Canadian fish, in other words, is short and broad in the direction of its height, while the Scotch species is long and narrow. Judging by the figures on Plate III of Decade X of British Fossils, published as one of the "Memoirs of the Geological Survey of the United Kingdom," the length of *P. Andersoni* is equal to about five and a half times its height, whereas, in the larger specimens of *P. curtum*, the length does not much exceed twice the height, and even in the very smallest, the length is not quite three and a half times the height.

On a cursory examination, the dorsal, caudal and anal fins of the present species appear to be continuous, but a closer scrutiny shows that the bases of the caudal and anal fins are separated by a short space.

The many points of resemblance between Phaneropleuron and the living *Ceratodus Forsteri* of Queensland, both in their internal and external structure, have long ago been pointed out by Prof. Cope and Dr. Gunther. The notochordal skeleton, lobate paired fins, cycloidal scales, triangular patches of palatal teeth, and the peculiar cranial plates of Dipterus shew that it too must have been very nearly related to Phaneropleuron.

IX.—*On some Marine Invertebrata dredged or otherwise collected by Dr. G. M. Dawson, in* 1885, *in the northern part of the Strait of Georgia, in Discovery Passage, Johnstone Strait, and Queen Charlotte and Quatsino Sounds, British Columbia; with a Supplementary List of a few land and fresh water shells, fishes, birds, etc., from the same region.* *By* J. F. WHITEAVES.

(Read May 27, 1886.)

As stated in his preliminary report,[1] Dr. Dawson's geological explorations of certain parts of the coast of British Columbia, in the summer of 1885, in which he was assisted by Mr. D. B. Dowling, were prosecuted by means of a schooner. In the intervals of the more purely geological work, this mode of locomotion afforded many opportunities, which were utilized to their fullest extent, for collecting marine invertebrata, on the shore, by the towing net or by the dredge. The title of the present paper sufficiently indicates the area examined, at many points within which collections were made at low tide. The material collected by the towing net, being to a large extent microscopical in its character, has not yet been examined. The dredge was used successfully at depths of of from seven to fifty fathoms, at the following localities:—

STATIONS.

STRAIT OF GEORGIA.

No. 1.—Ballinac Channel, opposite Lasqueti Island, in forty fathoms.
2.—False Bay, Lasqueti Island, in ten to twenty fathoms, sand and gravel.
3.—Off the mouth of Qualicum River, Vancouver Island, in forty fathoms, sand and gravel.
4.—Off the north end of Texada Island, in fifty fathoms, sandy mud,
5.—Between Hernando and Cortez Islands, in eight to twenty fathoms, sand.
6.—Between Mary and Cortez Islands, in fifteen to twenty fathoms, sand.

DISCOVERY PASSAGE.

7.—Duncan Bay, Vancouver Island, in ten to twenty fathoms, sand and gravel.
8.—Elk Bay, Vancouver Island, in twenty to twenty-five fathoms, sand and gravel.

JOHNSTONE STRAIT.

9.—Blinkinsop Bay, on the mainland of British Columbia, in ten fathoms, sand and mud.
10.—Forward Bay, Cracroft Island, in fifteen to twenty-five fathoms.

QUEEN CHARLOTTE SOUND.

(Including Blackfish and Fife Sounds and Broughton Strait.)

11.—Farewell Harbour, between Swanson, Lewis and Berry Islands, in nine fathoms, gravel.
12.—Fresh Water Bay, Swanson Island, Blackfish Sound, in ten fathoms, gravel and coarse sand.

[1] Summary Report of the Operations of the Geological and Natural History Survey of Canada to December 31st, 1885. Ottawa, 1886, pp. 4, 8.

STATIONS. QUEEN CHARLOTTE SOUND. (*Continued.*)

No. 13.—Cullen Harbour, Broughton Island, Fife Sound, in four to eight fathoms, sand and mud.

14.—Alert Bay, on the west coast of Cormorant Island, and nearly opposite the mouth of the Nimpkish River, Vancouver Island, in Broughton Strait, in ten fathoms, sand and mud.

15.—Between Alert Bay and the mouth of the Nimpkish River, Vancouver Island, in ten to twenty fathoms, gravel.

16.—Near Suquash, off Pulteney Point, Malcolm Island, Broughton Strait, in twenty-five fathoms, sand, gravel and dead shells.

17.—Off False Head, Vancouver Island, in thirty fathoms, sand, gravel and dead shells.

18.—Off Blunden Harbour, mainland of British Columbia, in six to ten fathoms, sand.

QUATSINO SOUND, NORTH-WEST COAST OF VANCOUVER ISLAND.

19.—Quatsino Sound, off Entrance Island, in from thirty to fifty fathoms, mud and sand.

20.—Forward Inlet, Quatsino Sound, in ten to twenty fathoms, mud.

Owing to the systematic way in which the collections were made, the series of marine invertebrata now reported upon is by far the most extensive and important that has yet been made by any of the exploring parties of the Survey. The crustacea, with the exception of the minute and for the most part larval forms collected in the towing net, have been kindly examined by Prof. S. J. Smith, of Yale College, who will report on them separately. The sponges, hydroids (with one exception), polyzoa, and worms, have not yet been studied. Including the foraminifera, the number of species that have been identified so far is approximately as follows:—

	No. of Species.
Foraminifera	19
Hydroida	1
Anthozoa	2
Echinodermata	15
Tunicata	1
Brachiopoda	4
Lamellibranchiata	54
Gasteropoda	88
Cephalopoda	1
TOTAL	185

At station No. 7, the sand which came up in the dredge, when washed and examined under the microscope, was found to be unusually rich in diatomaceæ. Among these, connected frustules of *Himantidium*, *Tabellaria* and *Grammatophora marina* are frequent, associated with separate frustules of *Arachnoidiscus Ehrenbergii* (rare), *Amphitetras antediluviana*, and of species belonging to the genera *Amphora*, *Campylodiscus*, *Coscinodiscus*, *Fragilaria*, *Gyrosigma*, *Licmophora*, *Navicula*, *Podosphænia*, *Surirella* and *Triceratium*.

Samples of the sand, mud, etc., dredged from the bottom at ten of these stations were saved to be examined for foraminifera. The species from the Vancouver district do not appear to have previously been studied by any naturalist, and the present list of the foraminifera of that region, though making no pretence to completeness, is believed to be the first that has yet been published. The largest and most conspicuous form is the *Rhabdammina abyssorum* of M. Sars, which was taken abundantly at three of the stations.

It had been dredged by the writer before, in 1873, at a depth of 200 fathoms in the Gulf of St. Lawrence. Other remarkable forms are double examples of *Discorbina Parisiensis*, which are far from uncommon in Dr. Dawson's dredgings; large varieties of *Cristellaria cultrata*, and a Frondicularia which, although common as a fossil in the Chalk of Europe and England, was previously unknown as a living species.

Among the echinodermata, the most interesting species collected is the *Astrogonium granulare*, which is new to the fauna of the Pacific.

Of the lamellibranchiate bivalves, two, viz., *Pecten Alaskensis* and *Yoldia thraciæformis*, are arctic or subarctic shells which had not previously been taken so far to the south as the Vancouver region, while, on the other hand, *Limatula subauriculata* and *Leda acuta* are species which have not hitherto been recorded as occurring so far to the north, on the west coast of North America.

The number of species of gasteropoda collected is unusually large, and among these, *Leptochiton cancellatus*, *Bela violacea*, *Cancellaria circumcincta*, *Admete viridula*, and *Sipho Verkruzeni* are northern forms new to the Vancouver district; while *Solariella peramabilis* and *Barleeia subtenuis* are Californian shells now for the first time placed upon record as living within it. *Astarte undata* and *Eulima incurva* (=*distorta* auct.) if correctly identified, seem to be new to the fauna of the west coast of North America; *Margarita cidaris*, of which a fine series was obtained, was previously known only from a single specimen; and *Cadulus aberrans* and *Leptochiton punctatus* are here described for the first time.

It would appear that the outer and exposed western coast of Vancouver Island is tenanted by a somewhat different assemblage of marine invertebrata from that which lives in its eastern, south-eastern and more land-locked waters. So far, *Tellina Bodegensis*, *Cadulus aberrans*, *Pachypoma gibberosum*, *Chlorostoma funebrale* and *Olivella biplicata* have been found by the Survey collectors on the west and north coast of the Island only, while *Acmæa instabilis*, *Cryptobranchia concentrica*, *Haliotis Kamtschatkana* and *Phoreus pulligo*, though not exclusively confined to the outer coast, appear to be rare in its eastern and south-eastern waters. The exact geographical distribution of the different species around the coast of Vancouver Island, however, has yet to be ascertained, and the preceding remarks have only been written with the view of directing attention to the subject.

For critical and valuable suggestions in regard to some of the mollusca collected, and for the identification of eight species of gasteropoda, the writer is indebted to Mr. W. H. Dall of the United States National Museum at Washington.

The following is a list of the species that have been identified so far.

Foraminifera.

Miliolina seminulum, *L.* Strait of Georgia at station No. 2, Discovery Passage at station No. 7, and Queen Charlotte Sound at station No. 17,—one specimen at each.

Miliolina Ferussacii, *d'Orbigny.* With the preceding at station No. 17, one specimen.

Rhabdammina abyssorum, *M. Sars.* Strait of Georgia at stations Nos. 4 and 5, Queen Charlotte Sound at station No. 17, and Quatsino Sound at station No. 20,—abundant at each.

HAPLOPHRAGMIUM CANARIENSE, *d'Orbigny*. Strait of Georgia at station No. 3, Discovery Passage at station No. 7, Queen Charlotte Sound at station No. 17, and Quatsino Sound at station No. 20,—not rare.

TROCHAMMINA SQUAMATA, *Jones and Parker*. Strait of Georgia at station No. 2, and Quatsino Sound at station No. 19,—not common.

BULIMINA PYRULA, *d'Orbigny*. Johnstone Strait at station No. 9, five specimens.

LAGENA SULCATA, *Walker and Jacob*. Discovery Passage at station No. 7, a few specimens.

NODOSARIA (DENTALINA) PAUPERATA, *d'Orbigny*. Strait of Georgia at stations Nos. 2 and 4, but in very small numbers.

FRONDICULARIA CANALICULATA, *Reuss*.

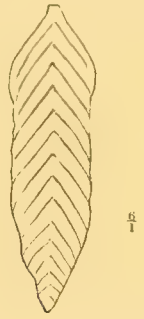

FIG. 1.—*Frondicularia canaliculata*, Reuss. Drawn from a living specimen dredged in the Strait of Georgia, and enlarged six diameters.

Verstein Bohm. Kreid, 1845, Pt. I. p. 31. Pl. VIII. Figs. 20, 21.

Strait of Georgia, at station No. 3, one perfect living specimen and a fragment of another, and at station No. 4, eight perfect and living specimens. This species, for the identification of which the writer is indebted to Mr. H. B. Brady, has long been known as a fossil of the Chalk Formation of Bohemia and England, but the specimens dredged by Dr. Dawson are the first that have been discovered in a living state.

CRISTELLARIA CULTRATA, *Montfort*. Strait of Georgia at station No. 4, four specimens of a large variety in which the sutures are prominently overlaid by raised lines of shelly deposit.

CRISTELLARIA CULTRATA, *var*. With the terminal end straightened and the shape like that of *C. reniformis* and *C. compressa*, but the sutures are strongly arched. A single specimen from the same station as the preceding.

POLYMORPHINA LACTEA, *Walker and Jacob*. Discovery Passage at station No. 7, one specimen.

POLYMORPHINA COMPRESSA, *d'Orbigny*. Strait of Georgia at station No. 4, Queen Charlotte Sound at stations Nos. 13 and 17, and Quatsino Sound at station No. 20,—not uncommon. Some of the specimens have as many as twelve segments, and the sutures are not excavated.

DISCORBINA PARISIENSIS, *d'Orbigny.* Discovery Passage at station No. 7, and Queen Charlotte Sound at stations Nos. 14 and 17,—not uncommon. Double specimens, in which the bases of two shells have grown together, or specimens which have been double, but which have been broken apart by some cause unknown, are more frequent than normal and single examples. In the ninth volume of the Zoology of the "Challenger" Expedition (p. 649) Mr. Brady says "it is probable that the phenomenon is to be accounted for in the same way in all cases, that it is brought about by the extension of a lobe of sarcode from the mouth of the parent test, the subsequent division of the nucleus, and the continued growth of the new individual without separation from the parent, a very similar process to that minutely watched by Gruber in a species of *Euglypha.*"

TRUNCATALINA LOBATULA, *Walker and Jacob.* Abundant, living and attached to shells, stones, etc., at most of the stations at which the dredge was used. Dead and detached specimens are frequent also in sand, etc., from stations Nos. 2, 7 and 17.

PULVINULINA KARSTENI, *Reuss.* Discovery Passage at station No. 7, four specimens, and Johnstone Strait at station No. 9, one specimen.

ROTALIA BECCARII, *L.* Discovery Passage at station No. 7, Queen Charlotte Sound at station No. 14 and Quatsino Sound at station No. 20,—a few examples at each.

NONIONINA SCAPHA, *Fichtel and Moll.* Johnstone Strait at station No. 9, and Queen Charlotte Sound at station No. 17,—apparently not very common.

POLYSTOMELLA CRISPA, *L.* Queen Charlotte Sound at stations Nos. 14 and 17, and Quatsino Sound at station No. 9,—not uncommon.

POLYSTOMELLA STRIATOPUNCTATA, *Fichtel and Moll.* Johnstone Strait at station No. 9, nine specimens. Two specimens were also noted in sand dredged at a depth of two fathoms in Comox Harbour, Vancouver Island.

HYDROZOA.

ALLOPORA VENUSTA, *Verrill.* Queen Charlotte Sound at station No. 15, several specimens.

ANTHOZOA.

PARACYATHUS CALTHA, *Verrill.* Strait of Georgia at station No. 5, one specimen, and station No. 6, four specimens.

BALANOPHYLLIA ELEGANS, *Verrill.* Strait of Georgia at station No. 5, one specimen, and station No. 6, two specimens. Discovery passage at station No. 7, four specimens.

OPHIUROIDEA.

OPHIOGLYPHA LUTKENI, *Lyman.* Discovery Passage at station No. 7, a few specimens, and Queen Charlotte Sound at station No. 17, abundant.

Asteroidea.

Asterias ochracea, *Brandt.* Low water, Malaspina Inlet, one small specimen.

Asterias conferta, *Stimpson.* Low water, Malapina Inlet, five fine specimens. Discovery Passage, at low water, one specimen.

Asterias Troscheli, *Stimpson.* Several specimens of an Asterias with five long slender rays and a very small disk, which are probably referable to this species, were collected by Dr. Dawson at low water at the northern end of the Strait of Georgia, at the entrance to Malaspina Inlet, at Redonda Island (to the north-east of Cortez Island) and in Discovery Passage. The smaller specimens from these localities agree very well with Stimpson's description of *A. Troscheli;* but the larger ones, which attain to a maximum diameter of rather more than a foot, and which are not very well preserved, do not shew very clearly the peculiar pentagon formed by clusters of spines in the centre of the upper surface of the disk, nor the marked disparity in size between the larger and smaller dorsal spines, that are said to be characteristic of the species. These larger specimens are precisely similar to a star-fish collected by Mr. James Richardson in 1874, at low water, near Victoria, Vancouver Island, which was doubtfully and perhaps incorrectly referred to the *A. epichlora* of Brandt in the "Canadian Naturalist" of December, 1878, but both they and it are quite different to the specimens from the Queen Charlotte Islands which were called *A. epichlora*, but with a query, by the writer, on Prof. Verrill's authority, in an appendix to Dr. Dawson's report on those islands.[1] Since that appendix was written, however, two very typical and well preserved examples of *A. Troscheli* have been detected among Dr. Dawson's collections from the Queen Charlotte Islands.

Asterias hexactis, *Stimpson.* Taken rather sparingly, living, at low tide in Seymour Narrows, Discovery Passage, Johnstone Strait and Queen Charlotte Sound. A few badly preserved and small specimens of a six-rayed star-fish, which is also probably *A. hexactis*, were dredged at station No. 14.

Pycnopodia helianthoidea, *Brandt.* (Sp.) Hernando Island, Strait of Georgia, at low water, one specimen.

Solaster Stimpsoni, *Verrill.* Low water at Port Neville, on the mainland of British Columbia and on the north side of Johnstone Strait,—several. Twelve specimens of a Solaster, which seems to be only a variety of this species, were dredged in Queen Charlotte Sound at station No. 14. These differ from the type of *S. Stimpsoni* principally in the unusually large size of the disc and in the shortness of the rays, which latter are uniformly ten in number. The spines at the angles near the mouth, also, are apparently more numerous.

Solaster Dawsoni, *Verrill.* Beach at Powell Island, Strait of Georgia; one adult example. Entrance to Malaspina Inlet, at low water; one small specimen. Low water at Johnstone Strait and in the Goletas Channel; abundant.

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[1] Report of Progress of the Geological Survey of Canada for 1878-79, p. 192 B.

CRIBRELLA LÆVIUSCULA, *Stimpson.* Low water at the entrance to Malaspina Inlet, in the Goletas Channel, and on the coast between Nahwitti village and Quatsino Sound, —several from each of these localities.

DERMASTER IMBRICATUS, *Perrier.* (=*Asteropsis imbricata*, Grube.) Beach at Hernando Island, two large specimens; low water at the entrance to Malaspina Inlet, one specimen; and Johnstone Strait, one specimen.

MEDIASTER ÆQUALIS, *Stimpson.* Low water at the north end of Malcolm Island, Queen Charlotte Sound, one fine specimen.

ASTROGONIUM GRANULARE, *O. F. Muller.* One beautiful living example of this rare species, which is now for the first time recorded as occurring in the North Pacific, was dredged in forty fathoms in the Strait of Georgia, off the mouth of the Qualicum River. It is almost precisely similar to a specimen of the same species taken some years ago off Halifax, Nova Scotia, and now in the Redpath Museum in Montreal. For the loan of the latter, for comparison, the writer is indebted to Sir William Dawson.

ECHINOIDEA.

DENDRASTER EXCENTRICUS, *Valenciennes.* (Sp.) Beach at Mary Island, Strait of Georgia, several dead and bleached specimens denuded of their spines. Low water at Savary Island, in the same strait, alive and numerous.

LOXECHINUS PURPURATUS, *Stimpson.* (Sp.) Common almost everywhere along the coast.

STRONGYLOCENTROTUS DROBACHIENSIS, *Mull.* With the preceding, and equally common.

HOLOTHUROIDEA.

PENTACTA FRONDOSA, *Gunner.* Two specimens of a very large Holothurian which appear to belong to this species, though they have not been examined microscopically, were dredged in Queen Charlotte Sound; one at station No. 11 and one at station No. 12.

A number of small Holothurians, which have yet to be studied, were dredged in Queen Charlotte Sound, at station No. 14.

TUNICATA.

CYNTHIA (HALOCYNTHIA) PYRIFORMIS, *Rathke.* Queen Charlotte Sound at station No. 18, two living specimens.

BRACHIOPODA.

RHYNCHONELLA PSITTACEA, *L.* Discovery Passage at station No. 7, one fresh ventral valve. Low tide, Johnstone Strait, a few small but living specimens.

TEREBRATULINA UNGUICULA, *Carpenter*. Strait of Georgia, near Comox, in forty fathoms; one small living specimen. Discovery Passage at station No. 7, a large ventral valve. Low tide, Johnstone Strait, one small living specimen; and Johnstone Strait at station No. 10, two small living specimens.

The *Terebratula unguicula* of the late Dr. P. P. Carpenter was regarded as merely a local variety of the European *T. caput-serpentis* by the late Dr. Thomas Davidson. A series of adult and perfect examples of *T. unguicula*, dredged by Mr. James Richardson in 1876 in the Strait of Georgia, was sent by the writer to Dr. Davidson, for examination, in the fall of 1884. In a letter dated November 29, 1884, Dr. Davidson writes :—"The specimens named *Terebratulina unguicula* are only a variety of *T. caput-serpentis*. I will describe it in my monograph" (one on recent brachiopoda, then in course of preparation) "as *Terebratulina caput-serpentis*, var. *unguicula*, Carpenter. I compared all your Vancouver examples very minutely with a number of European specimens of Linne's species, and feel confident that *T. unguicula* is not a distinct species."

LAQUEUS CALIFORNICUS. *Koch*. Discovery Passage at station No. 7, one dead but perfect shell and a large dorsal valve. Johnstone Strait at station No. 10, five living adult specimens and several young. Race Passage, Johnstone Strait, two small but living specimens.

TEREBRATELLA TRANSVERSA, *Sowerby*. (=*T. caurina*, Gould.) Low tide, Strait of Georgia, many small but living and strongly ribbed specimens. Entrance to Malaspina Inlet, at low water, one living specimen. Discovery Passage at station No. 7, three small living specimens and one dead shell. Johnstone Strait at station No. 10, two adult living shells and one small one. Queen Charlotte Sound at station No. 12, one small living shell, and at station No. 18, five small, living specimens.

At these localities, some of the specimens have strong, radiating ribs, while others are almost entirely smooth, but there are intermediate gradations between the ribbed and the smooth forms, which latter is the one represented by Sowerby in the "Thesaurus Conchyliorum," as the type of *T. transversa*.

LAMELLIBRANCHIATA.

PLACUNANOMIA MACROSCHISMA, *Deshayes*. Entrance to Malaspina Inlet, at low water; three small, living specimens attached to *Ostrea lurida*. Strait of Georgia at station No. 2, two rather small, living specimens. Quatsino Sound, Vancouver Island, one large and two small living shells.

OSTREA LURIDA, *Carpenter*. Entrance to Malaspina Inlet, at low tide, two living specimens. A number of good specimens of this species, which were said to have been taken near Comox, were purchased in Victoria, Vancouver Island. Bradley Lagoon, Blunden Harbour, Queen Charlotte Sound, on the mainland side, abundant. This last is the most northerly locality yet recorded for oysters on the coast of British Columbia.

HINNITES GIGANTEUS, *Gray.* Entrance to Malaspina Inlet, associated with the two preceding species, one rather small and dead specimen. Low water at Fort Rupert, on the north-east coast of Vancouver Island, one adult living shell, and a similar one from the entrance to Quatsino Sound, also at low water.

PECTEN ALASKENSIS, *Dall.* Quatsino Sound at station No. 20, one small but living specimen. This species, which has hitherto been recorded as occurring only at "North Harbor, Unga Island," and "Port Etches, Chugach Gulf," is new to the Vancouver region.

PECTEN HASTATUS, *Sowerby.* (=*P. hericeus*, Gld.) Strait of Georgia at station No. 6, one living, adult shell, with the exterior of both valves nearly covered by an encrusting sponge. Goletas Channel, one small but living shell. Quatsino Sound at station No. 19, five adult, living and brightly coloured specimens of the typical form of the species, in which the principal ribs are few, distant, and ornamented with erect vaulted scales.

PECTEN HASTATUS, *var.* HINDSII, *Carpenter.* Strait of Georgia at station No. 5, two rather small, living shells and a few fragments. Discovery Passage at station No. 7, two small, living shells and three single valves. Johnstone Strait at station No. 10, four medium sized, living specimens (one passing distinctly into the var. *rubidus*) and a few very small ones. Queen Charlotte Sound at station No. 14, one living specimen; at station No. 17, three small living shells; and at station No. 18, one small, living shell. Quatsino Sound at stations No. 19 and 20, a few living specimens of various sizes.

LIMATULA SUBAURICULATA, *Montagu.* Johnstone Strait at station No. 10, and Queen Charlotte Sound at station No. 14, a single living specimen from each of these localities. Not included in the Vancouver fauna in Dr. Carpenter's "Guide to the Diagnosis of the Vancouver and Californian Shells," on pages 122-150 of his last report on "The Mollusks of Western North America," published in 1872 by the Smithsonian Institution.

YOLDIA LANCEOLATA, *J. Sowerby.* Quatsino Sound at station No. 20, a few living specimens.

YOLDIA (PORTLANDIA) THRACIÆFORMIS, *Storer.* From the same station as the last, two small but living specimens. This species also is new to the Vancouver district.

LEDA FOSSA? *Baird.* Discovery Passage at station No. 7, one single and worn valve.

LEDA MINUTA, *O. Fabricius.* Quatsino Sound at station No. 19, two living specimens.

LEDA ACUTA, *Conrad.* (=*L. cuneata*, Sowerby.) Same locality and station as the preceding; ten perfect specimens (most of which were living) and three single valves.

A single valve of a Leda from Houston Stewart Channel, Queen Charlotte Islands, which was referred by the writer to the *Leda cælata* of Hinds (on p. 200 B of the Report of Progress of the Geological Survey for 1878-79) is almost certainly referable to *L. acuta*, Conrad, of which, according to Dall, *L. cuneata*, Sowerby, is a synonym. On the other hand, in the sixth volume of the "American Journal of Conchology," (p. 55) Dr. J. G. Cooper suggests that *Leda cuneata* may be only a variety of *L. cælata.*

NUCULA (ACILA) LYALLI, *Baird.* Strait of Georgia at station No 9, Johnstone Strait at stations Nos. 9 and 10, and Queen Charlotte and Quatsino Sounds at stations Nos. 12, 14, 17 and 20. Taken more or less plentifully and living at each of these localities, in from ten to thirty fathoms.

NUCULA TENUIS (*Montagu*), *var.* LUCIDA, *Gould.* Johnstone Strait at station No. 9, several living specimens. Quatsino Sound at station No. 20, abundant, living but small.

PECTUNCULUS SUBOBSOLETUS. (=*Axinæa subobsoleta*, Carpenter.) Discovery Passage at station No. 7, two living specimens. Queen Charlotte Sound at station No. 14, three living shells, and at station No. 15, ten living specimens. North or north-west coast of Vancouver Island, between Nahwitti Bar and Quatsino Sound, at low water, one living shell.

CRENELLA DECUSSATA, *Montagu.* Strait of Georgia at station No. 5, two living examples of an unusually large form of the species. Queen Charlotte Sound at station No. 12, three living specimens, of the same size; and station No. 14, four specimens of the usual size and one (living) which measures, length, twelve mm., height, eleven mm., and maximum thickness, seven mm and a half.

MODIOLARIA LÆVIGATA, *Gray.* Port Neville, on the mainland of British Columbia, near Johnstone Strait, at low water, one living specimen associated with *Saxicava rugosa.*

MODIOLARIA NIGRA, *Gray.* Strait of Georgia at station No. 5, Discovery Passage at station No. 7, and Queen Charlotte Sound, at stations Nos. 14 and 16,—a few immature living specimens at each of these localities.

MODIOLA MODIOLUS, *L.* Johnstone Strait at station No. 10, six half-grown, living shells, with a simply bearded epidermis. Queen Charlotte Sound at stations Nos. 11, 12, 14, 16 and 18,—a few living, but for the most part, very young specimens at each. The species usually lives in the crevices of rocks, or between or on stones.

MYTILUS EDULIS, *L.* A few specimens of the fry of this very common and ubiquitous species occur in dredgings in the Strait of Georgia, at station No. 5.

MYTILUS CALIFORNIANUS, *Conrad.* Low water at Galiano Island, in the Strait of Georgia, and dredged at station No. 11, in Queen Charlotte Sound.

KELLIA LAPEROUSEI, *Deshayes.* Low tide, entrance to Malaspina Inlet; one fine and adult living specimen, which measures twenty-five mm. (or just one inch) in length by twenty mm. in height, and a few smaller ones.

KELLIA LAPEROUSEI, *var.* CHIRONII, *Carpenter.* Strait of Georgia, at low water, one living shell; and Johnstone Strait, also at low water, seven living specimens.

DIPLODONTA ORBELLA, *Gould.* Entrance to Malaspina Inlet at low water, three adult living specimens; also north or north-west coast of Vancouver Island, between Nahwitti Bar and Quatsino Sound, at low water, one adult and living shell.

CRYPTODON FLEXUOSUS, *L.* Strait of Georgia at station No. 2, four large and perfect specimens; and Quatsino Sound at station No. 20, two equally perfect specimens.

CRYPTODON SERICATUS, *Carpenter.* (Not "serricatus.") Quatsino Sound at station No. 20, several small but living specimens. In a letter to the writer, Mr. Dall says "the specific name of this shell is misspelled in Dr. Carpenter's last report, but the mistake was corrected by him in MS."

LUCINA FILOSA, *Stimpson.* Quatsino Sound at station No. 19, one small but living shell; and at station No. 20, a large and perfectly fresh single valve.

LUCINA TENUISCULPTA, *Carpenter.* Strait of Georgia at station No. 2, one living specimen; and Quatsino Sound at station No. 19, abundant, living.

VENERICARDIA BOREALIS, *Conrad.* Living, but usually of small size, at the following localities:—Strait of Georgia at station No. 5, Johnstone Strait at station No. 10, Queen Charlotte Sound at stations Nos. 12, 14, 15, 17 and 18; and Quatsino Sound at station No. 19. A few dead valves of this shell were dredged at station No. 7, in Discovery Passage.

ASTARTE UNDATA? *Gould*, var. Strait of Georgia at station No. 5, two living and full-grown specimens; Discovery Passage at station No. 7, two living specimens and several single valves, and Johnstone Strait at station No. 10, one living and unusually large specimen.

The shells from station No. 5 can scarcely be separated from examples of a variety of *A. undata* dredged by the writer, in 1873, between Pictou Island and Cape Bear, P.E.I.; while those from stations No. 7 and 10 are more transversely elongated and more like *A. elliptica* in shape, but their ribs are fewer (some fourteen or fifteen in number) and more prominent, and shew little if any tendency to become obsolete near the ventral margin. A single dead and immature valve of an Astarte, dredged by Dr. G. M. Dawson off Metlakatla in 1878, and identified by the writer, with doubt, as possibly the *A. semisulcata* of Leach, in the Report of Progress of the Geological Survey of 1878-79 (p. 197 B) is certainly identical with the shells here provisionally referred to *A. undata.*

ASTARTE ESQUIMALTI, *Baird.* Strait of Georgia at station No. 5, two living specimens; Discovery Passage at station No. 7, abundant, alive; Johnstone Strait at station No. 10, two living specimens; and Queen Charlotte Sound at station No. 12, four living shells, and at station No. 14, abundant and alive. In the specimens from these localities the irregularity of the concentric ribs is very slight and scarcely appreciable without the aid of a lens.

CARDIUM BLANDUM, *Gould.* Strait of Georgia at station No. 5, Discovery Passage at station No. 7, Johnstone Strait at station No. 10, and Queen Charlotte Sound at stations Nos. 12, 13, 16 and 17. A few living specimens of all sizes from each of these localities.

CARDIUM NUTTALLI, *Conrad.* Common at or near low water mark throughout the district.

SAXIDOMUS SQUALIDUS, *Deshayes.* Abundant at low tide round the whole coast. A few small specimens of the present species were dredged in Discovery Passage at station No. 7, and in Queen Charlotte Sound at stations Nos. 12 and 16.

TAPES STAMINEA, *Conrad.* Common almost everywhere on mud flats at low water. This and the two preceding species are eaten by the Indians, who call this the "small round clam."

VENUS KENNERLYI, *Reeve.* Discovery Passage at station No. 7, one full-grown living specimen and a very small one; also in Queen Charlotte Sound at station No. 12, one very small living shell.

PSEPHIS LORDI, *Baird.* Living, and more or less abundant, in the Strait of Georgia at station No. 5; in Discovery Passage, at station No. 7; in Johnstone Strait at stations Nos. 9 and 10; and in Queen Charlotte Sound at stations Nos. 12, 13, 14 and 17.

CLEMENTIA SUBDIAPHANA, *Carpenter.* Quatsino Sound at station No. 19, three large, dead, single valves.

TELLINA BODEGENSIS, *Hinds.* North and north-west coast of Vancouver Island, between Nahwitti Bar and Quatsino Inlet, at low water, six living specimens.

MÆRA SALMONEA, *Carpenter.* Low water at the entrance to Quatsino Sound, and Queen Charlotte Sound at station No. 16,—one living specimen at each of these localities. By inadvertence, the name of this species was printed *M. variegata* in the list of shells from the Queen Charlotte Islands already referred to in this paper.

ANGULUS VARIEGATUS, *Carpenter.* Quatsino Sound at station No. 19, a fully grown living specimen.

ANGULUS MODESTUS, *Carpenter.* Strait of Georgia at station No. 2, five living specimens. Probably only a pale local variety of the species last mentioned.

MACOMA OBTUSA, *Carpenter.* (Sp.) Discovery Passage at station No. 7, one adult and perfect shell; Queen Charlotte Sound at stations Nos. 15 and 16, one specimen from each, and Quatsino Sound at station No. 19, two living specimens.

MACOMA CARLOTTENSIS, *Whiteaves.* Johnstone Strait at station No. 9, abundant, alive; Quatsino Sound at station No. 20, seven adult living specimens.

MACOMA CALCAREA, *Chemnitz.* (=*M. sabulosa*, Spengler.) Quatsino Sound at stations Nos. 19 and 20, one perfect, living specimen from each.

MACOMA INCONSPICUA, *Broderip and Sowerby.* Queen Charlotte Sound at stations Nos. 16 and 17, three living specimens at each. A single shell also, which appears to be an unusually large form of this species, was dredged at station No. 17.

MACOMA NASUTA, *Conrad.* Abundant at low water in Johnstone Strait. One small, living specimen also was dredged in Discovery Passage at station No. 7.

LYONSIA (ENTODESMA) SAXICOLA, *Baird.* Abundant, of large size and living, at low water, in crevices of rock among kelp and other seaweed, at Port Neville, on the mainland of British Columbia, near the east end of Johnstone Strait. Low tide at Beaver Harbour, Vancouver Island, one living specimen. Queen Charlotte Sound at station No. 11, one living adult shell.

LYONSIA CALIFORNICA, *Conrad.* Strait of Georgia at station No. 2, one living shell; and station No. 5, abundant and alive. Discovery Passage at station No. 7, several; and at station No. 8, one, alive. Queen Charlotte Sound, a few living specimens at stations Nos. 12, 14 and 16. As is usual in this genus, the shell, when freshly taken, is often nearly covered with a fine, sandy envelopment.

THRACIA CURTA, *Conrad.* Quatsino Sound at station No. 19, a large left valve, which measures a little over two inches in length by one inch and five-eighths in height.

PANDORA (KENNERLIA) GRANDIS, *Dall.* Discovery Passage at station No. 7, two nearly adult living shells and one adult and perfect but dead specimen. Johnstone Strait at station No. 10, one adult, living shell.

PANDORA (KENNERLIA) FILOSA, *Carpenter* Strait of Georgia at station No. 5, three living specimens—one adult and two small. Discovery Passage at station No. 8, three young and living specimens and one full grown but dead shell. Quatsino Sound at station No. 19, six adult, living specimens; and at station No. 20, one living specimen.

NEÆRA PECTINATA, *Carpenter.* One or two living specimens from each of the following localities:—Strait of Georgia at station No. 5, Discovery Passage at station No. 8, Johnstone Strait at station No. 10, Queen Charlotte Sound at station No. 17, and Quatsino Sound at station No. 19. The largest specimen, which measures twenty one mm. in length and thirteen mm. in height, is from the locality last mentioned.

SCHIZOTHÆRUS NUTTALLI, *Conrad.* Common at low tide at many places along the coast and used for food. The only localities from which specimens were brought are Galiano Island in the Strait of Georgia, and Fort Rupert, Beaver Harbour, on the north coast of Vancouver Island.

MYA TRUNCATA, *L.* A few young specimens of this species were dredged in Discovery Passage at station No. 8, in Johnstone Strait at station No. 10, in Queen Charlotte Sound at station No. 12, and in Quatsino Sound at station No. 20.

SAXICAVA PHOLADIS, *L.* (=*S. rugosa*, Lamarck.) A few specimens of this common littoral species were collected at low water at the entrance to Malaspina Inlet, at Port Neville, B. C., and Quatsino Sound. A living but immature specimen, also, was dredged at station No. 20 in Quatsino Sound.

GASTEROPODA.

TORNATINA EXIMIA, *Baird.* Strait of Georgia at station No. 5, Discovery Passage at stations Nos. 7 and 8, Queen Charlotte Sound at station No. 17, and Quatsino Sound at station No. 20. A few living specimens from each of these localities.

CYLICHNA ALBA, *Brown.* Associated with the above at stations Nos. 5 and 20, one specimen at the first locality and five at the last.

MELIBE (CHIORHÆA) LEONINA, *Gould.* On seaweed in Cullen Harbour, several.

DENDRONOTUS PURPUREUS? *Bergh.* Elk Harbour, one large and two small living specimens.

SIPHONARIA THERSITES, *Carpenter.* Living and apparently not uncommon, at low tide, in Johnstone Strait, on the east side of Queen Charlotte Sound; on the north and north-west coast of Vancouver Island, from Nahwitti Bar to Quatsino Sound, and in Quatsino Sound.

CADULUS ABERRANS. N. Sp.

FIG. 2.—*Cadulus aberrans.* Side view of an average specimen, enlarged three diameters.

Shell slender, moderately but distinctly curved, large and much elongated for the genus, increasing very slowly but regularly in diameter, not distinctly (if at all) swollen in advance of the middle, and very slightly and scarcely perceptibly constricted immediately behind the aperture. Test extremely thin, surface polished, very glossy and shining, smooth to the naked eye, but under a lens it is seen to be marked with minute and transverse but somewhat oblique lines of growth.

Length of an average, full-sized example, 13.5 mm.; greatest breadth of the same near the anterior end, 1.3 mm.

Very abundant in Quatsino Sound at station No. 20.

This little shell, which is nevertheless of large size for the genus, looks not unlike an immature Dentalium, and, at first sight, specimens of it might be easily mistaken for half-grown examples of *D. pretiosum*, Nuttall, which the Indians say occurs at the same locality. It may, however, be distinguished from any Dentalium by its thin test and highly polished outer surface, though the swelling of the shell in advance of the middle and the constriction behind the aperture, which are usually marked characters in the genus *Cadulus*, are reduced to a minimum in this species, and in most specimens are quite imperceptible.

The writer has been informed by Mr. Dall that there are specimens of this shell in the museum of the Smithsonian Institution at Washington, which were collected by Dr. J. G. Cooper at Catalina Island, California.

MOPALIA CILIATA, *Sowerby.* (Sp.) More or less abundant, living, at low tide, in Discovery Passage, Johnstone Strait, the Goletas Channel, and Quatsino Sound. One living specimen was dredged in Queen Charlotte Sound at station No. 13.

MOPALIA LIGNOSA, *Gould.* Living, at low tide, on the north side of the Strait of Georgia, in the Goletas Channel, and in Queen Charlotte and Quatsino Sounds.

MOPALIA WOSSNESSENSKYI, *Middendorf.* Associated with the two preceding species, but apparently very much rarer than either.

PLACIPHORELLA IMPORCATA, *Carpenter.* (Sp.) Johnstone Strait at station No. 10, one small, living specimen, with the girdle partly overgrown by a hydroid.

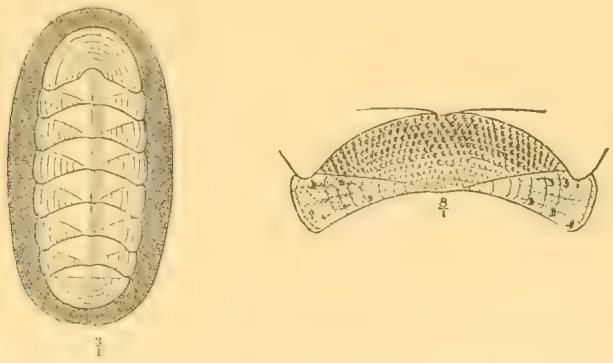
CRYPTOCHITON STELLERI, *Middendorf.* Discovery Passage, between Vancouver and Cortez Islands, in about one fathom of water, one living specimen. Low tide, Johnstone Strait, two living specimens; and on Thurlow Island, east end of Johnstone Strait, four living shells. Low tide, Beaver Harbour, Vancouver Island, one living specimen. One living specimen, also, was dredged in Queen Charlotte Sound at station No. 15.

Dr. Dawson states that this species is generally distributed on rocky ground at and below low tide mark, but that it is nowhere very abundant. This and the next-named species are cooked and eaten by Indians.

KATHERINA TUNICATA, *Sowerby.* On rocks at low water all over the coast, and in some places very abundant.

LEPTOCHITON CANCELLATUS, *Sowerby.* Queen Charlotte Sound at station No. 12, eleven small but living specimens, four of which have been identified with this species by Mr. W. H. Dall. Three specimens of a small, white Chiton, from station No. 14, appear also to belong to this species.

LEPTOCHITON PUNCTATUS. N. Sp.



FIGS. 3 and 4.—*Leptochiton punctatus.* The figure on the left hand side represents the type specimen enlarged three diameters, and that on the right one of the central valves, enlarged eight diameters to shew the sculpture.

Shell small, elongated, rather strongly elevated, back distinctly angulated; colour, pale cream or nearly white, but with a few small patches of reddish-brown on the girdle, and a narrow and non-continuous series of variously interrupted and broken up yellowish-brown spots upon the median line of all the valves but the anterior one. Girdle squamose, the scales closely imbricating, much broader than high, and distinctly striated when viewed under an achromatic microscope with a half-inch objective. Mucro central and tolerably distinct where not worn off; anterior valve marked with faint but rather numerous radiating striæ and

concentric lines of growth. Central areas of all the valves but the anterior one regularly pitted, as viewed by an ordinary simple lens of moderate power, the pitting being most distinct near the suture. These pits are the interstices between longitudinal, lightly curved and convergent raised lines, and the curved raised lines of growth. Lateral areas of the valves (exclusive of the anterior one) not so distinctly pitted, but more or less marked with faint radiating striæ, especially those of the anterior portion of the shell; those of the third to the seventh, both inclusive, each bearing from four to six distant, isolated, prominent and rounded tubercles on each side, three being usually placed on each of the lines which separate the lateral from the central areas.

Length of the only specimen collected, about fourteen millimetres; maximum breadth of the same, six and a half.

Discovery Passage at station No. 7, one living specimen.

An interesting and beautiful little species, apparently well characterized by the peculiarly punctate surface of the central area of the valves.

TONICELLA LINEATA, *Wood.* (Sp.) Frequent, living, at low water, on the north shore of the Strait of Georgia, in Malaspina Inlet, Discovery Passage, Race Passage in Johnstone Strait, Queen Charlotte Sound, and on the north and north-west coast of Vancouver Island, from Nahwitti Bar to Quatsino Sound. Taken abundantly from the stomach of a harlequin duck (*Histrionicus torquatus*) shot at Mittlenatch Island, in the Strait of Georgia. Dredged also in Queen Charlotte Sound at station No. 12.

ISCHNOCHITON INTERSTINCTUS, *Gould.* (Sp.) Low tide in Race Passage Johnstone Strait, and in Queen Charlotte Sound, but apparently not common. More abundant in Discovery Passage at station No. 7, in Johnstone Strait at station No. 10, in Queen Charlotte Sound at stations Nos. 12, 14, 15 and 16, and in Quatsino Sound at station No. 20.

ISCHNORADSIA TRIFIDA, *Carpenter.* (Sp.) Queen Charlotte Sound, one large, living specimen.

LEPIDOPLEURUS MERTENSII, *Middendorf.* (Sp.) Discovery Passage at station No. 7, two living specimens; and Queen Charlotte Sound at station No. 15, one living example.

ACMÆA (COLLISELLA) PATINA, *Eschscholtz.* Abundant, living at low tide in Johnstone Strait.

ACMÆA (COLLISELLA) PELTA, *Eschscholtz.* Common and alive at low tide at the north end of Texada Island, Strait of Georgia; in Discovery Passage, between Seymour Narrows and Elk Harbour; in Johnstone Strait; on the east side of Queen Charlotte Sound; and along the north and north-west coast of Vancouver Island, from Nahwitti Bar to Quatsino Sound. Numerous but dead specimens were dredged in Discovery Passage at station No. 7.

ACMÆA (COLLISELLA) PERSONA, *Eschscholtz.* Low tide in Discovery Passage, between Seymour Narrows and Elk Harbour, four adult, living specimens.

ACMÆA MITRA, *Eschscholtz.* Low tide at Malaspina Inlet in the Strait of Georgia, and Queen Charlotte and Quatsino Sounds. Dredged also in Queen Charlotte Sound at stations Nos. 12, 15 and 18, and at the entrance to Quatsino Inlet at station No. 19. Moderately abundant near low water mark almost everywhere.

ACMÆA INSTABILIS, *Gould.* Low tide on the north and north-west coast of Vancouver Island, between Nahwitti Bar and Quatsino Sound; three adult, but dead shells.

CRYPTOBRANCHIA CONCENTRICA, *Middendorf.* (=*Lepeta cæcoides*, Carpenter.) Queen Charlotte Sound at station No. 17, one living specimen; and Quatsino Sound at station No. 20, several.

GLYPHIS ASPERA, *Eschscholtz.* Common, living at low tide in Malaspina Inlet, Strait of Georgia; in Johnstone and Broughton Straits; in the Goletas Channel, and on the west coast of Vancouver Island, north of Quatsino Sound.

PUNCTURELLA CUCULLATA, *Gould.* Low water at Race Passage, Johnstone Strait, one large, living specimen. Dredged also alive, but sparingly, in Discovery Passage at station No. 7, in Queen Charlotte Sound at stations Nos. 12 and 17, and in Quatsino Sound at station No. 20.

PUNCTURELLA GALEATA, *Gould.* Dredged living, but in very small numbers, in Discovery Passage at station No. 7, in Johnstone Strait at station No. 10, in Queen Charlotte Sound at stations Nos. 12, 15 and 18, and in Quatsino Sound at station No. 20. Specimens sometimes occur which seem to be intermediate in their sculpture between this and the preceding species.

HALIOTIS KAMTSCHATKANA, *Jonas.* Living at a little below low tide at Port Neville, on the mainland of British Columbia, north of Johnstone Strait; at Beaver Harbour, on the north-east coast of Vancouver Island; in the Goletas Channel; and at the entrance to Quatsino Inlet. Dr. Dawson says that this species is most abundant in exposed situations on the northern and outer coast of Vancouver Island, but that it is rarely met with in the Strait of Georgia or other land-sheltered waters.

The animal, or foot of the animal, is eaten by the Indians, and dried for sale to the Chinese, while the nacreous interior of its shell is largely used by the Indians for inlaying and other ornamental or decorative purposes.

PACHYPOMA GIBBEROSUM, *Chemnitz.* On rocks and kelp at a little below low-water mark in Quatsino Sound; abundant at some localities.

The thick, calcareous operculum of this shell is used for ornamental inlaying, in wooden ware, by the Indians of the coast.

LEPTOTHYRA SANGUINEA, *L.* (Sp.) Living, at low tide, in Johnstone and Broughton Straits, in the Goletas Channel, and on the east side of Queen Charlotte Sound. Dredged, also, in Queen Charlotte Sound at station No 15, and in Quatsino Sound at station No. 20.

Mr. Tryon appears to be mistaken in supposing that the Californian shells which Dr. Carpenter referred to this species, have a "corneous" operculum and

are different from the *Turbo sanguineus* of Linnæus.[1] In a letter to the writer, Mr. Dall says:—"The west coast shell is the *sanguinea*, L.; is not the type of *Collonia*, Gray, which is African and umbilicated, and has a calcareous operculum. It inhabits Japan, California, and the Ægean Sea." The specimens collected by Dr. Dawson certainly have a calcareous operculum.

CHLOROSTOMA FUNEBRALE, *A. Adams.* Collected abundantly, living, at or a little below low tide level on the north and north-west coast of Vancouver Island, between Nahwitti Bar and Quatsino Sound. Apparently confined to the north and west coast of the island.

CALLIOSTOMA COSTATUM, *Martyn.* Low tide in Johnstone and Broughton Straits, in the Goletas Channel, and on the east side of Queen Charlotte Sound,—common and living. Dredged also, abundantly and alive, in Queen Charlotte Sound at station No. 15.

CALLIOSTOMA ANNULATUM, *Martyn.* Johnstone Strait at station No. 10, one small, living specimen. A much scarcer species than the preceding one on the coasts of Vancouver and the Queen Charlotte Islands.

GIBBULA (PHORCUS) PULLIGO, *Martyn.* Abundant at and a little below low water mark, in Johnstone and Broughton Straits, in the Goletas Channel, on the east side of Queen Charlotte Sound, and on the northern and western coasts of Vancouver Island; often on fronds and stems of Macrocystis.

The specimens from Carpenter Bay, which were referred by the writer to the *Chlorostoma brunneum* of Philippi, in a list of shells from the Queen Charlotte Islands, published in the Report of Progress of the Geological Survey of Canada for 1878-79 (p. 201 B), are forms of this species. The true *Chlorostoma brunneum* has not yet been found north of California.

SOLARIELLA PERAMABILIS, *Carpenter.* Six fine living specimens of this rare shell were dredged in Queen Charlotte Sound at station No. 17. The species had not previously been recorded as occurring north of California. Mr. W. H. Dall, who has examined three of the specimens collected by Dr. Dawson, says that they are "ruder and larger than those from the Santa Barbara Channel," and that the former "might perhaps be regarded as a local variety of the species." Dr. Paul Fischer ("Manuel de Conchyliologie," Paris, p. 826) says that *Machæroplax* of Friele (1877) is synonymous with *Solariella* of Searles Wood (1842).

MARGARITA CIDARIS, *A. Adams.* Johnstone Strait at station No. 10, two very young but living shells. Queen Charlotte Sound at station No. 17, a fine series of eighteen living specimens of all ages, several being adult, and the largest measuring forty six millimetres in height (or length) by about thirty-two in maximum breadth. Entrance to Quatsino Inlet at station No. 19, two half-grown and dead shells.

The only previously known specimen of "this very remarkable and unique shell," as Dr. P. P. Carpenter calls it, was found at Neeah Bay, Washington Territory, by Mr. J. G. Swan.

[1] See Structural and Systematic Conchology, ii. 306, 312.

In one of the specimens collected by Dr. Dawson the columella has a greenish iridescence not unlike that of some varieties of labradorite.

MARGARITA PUPILLA, *Gould.* Collected sparingly, alive, at low water mark in Beaver Harbour (on the north-east coast of Vancouver Island), in the Goletas Channel, on the east side of Queen Charlotte Sound, and at the entrance to Quatsino Sound. Dredged also, in small numbers but living, in the Strait of Georgia at stations Nos. 2, 5 and 6, in Discovery Bay at station No. 7, in Johnstone Strait at station No. 10, in Queen Charlotte Sound at stations Nos. 12, 14, 16, 17 and 18, and in Quatsino Sound, at station No. 20.

MARGARITA LIRULATA, *Carpenter* Discovery Passage at station No. 17, one very small living specimen; Queen Charlotte Sound, at station No. 12, about twenty adult living specimens; and Quatsino Sound at station No. 20, one living and full-grown shell.

In the seventh volume of the "American Journal of Conchology," (pp. 128, 129) Mr. Dall expresses the opinion that *Gibbula optabilis*, Cpr., *G. parcipicta*, Cpr., *G. funiculata*, Cpr., *G. succincta*, Cpr., and perhaps *G. lacunata*, Cpr., as well as *Margarita tenuisculpta*, Cpr., are all forms of the present "protean species."

MARGARITA HELICINA, *Fabricius.* Low tide in Johnstone Strait, three immature, living specimens. Dredged also in Queen Charlotte Sound at stations Nos. 12 and 16, one living, adult shell at each.

CREPIDULA DORSATA (*Broderip*), *var.* LINGULATA, *Gould.* (=*C. bilobata*, Reeve.) Low tide at the entrance to Malaspina Inlet, in the Strait of Georgia, and in Quatsino Sound; three or four living specimens at each locality. Dredged also very sparingly, but alive, in the Strait of Georgia at station No. 2, and in Johnstone Strait at station No. 10.

CREPIDULA ADUNCA, *Sowerby.* Entrance to Quatsino Sound at low water, and on the west coast of Vancouver Island, north of Quatsino Sound, also at low water,—a single specimen at each of these localities.

CREPIDULA NAVICELLOIDES, *Nuttall.* Dredged in very small numbers, but alive, in Queen Charlotte Sound at stations Nos. 12, 14 and 16. Mr. Tryon thinks that this shell is only a local variety of *C. Lessoni*, Broderip.

GALERUS FASTIGIATUS, *Gould.* Not uncommon and living, in Discovery Passage at station No. 7, in Johnstone Strait at station No. 10, and in Queen Charlotte Sound at stations Nos. 12, 14 and 16. The Galerus from the Queen Charlotte Islands, which was named *G. contortus*, Gould, by the writer, in the paper already referred to, is almost certainly *G. fastigiatus*, but this latter name, Mr. Tryon says, is a synonym of *G. mamillaris*, Broderip.

BIVONIA COMPACTA, *Carpenter.* Discovery Passage at station No. 7, a living specimen on *Trophon tenuisculptus*, Carpenter; and in Quatsino Sound at station No. 19, one specimen, also living, attached to the under valve of a typical example of *Pecten hastatus.*

MESALIA RETICULATA, *Mighels.* (=*Turritella lactea*, Moller, and *Mesalia lacteola*, Carpenter.) Dredged rather abundantly, living, in the Strait of Georgia at station No. 5, in Discovery Passage at station No. 8, in Johnstone Strait at station No. 10, in Queen Charlotte Sound at stations Nos. 12, 13, 14 and 17, and in Quatsino Sound at station No. 20.

BITTIUM FILOSUM, *Gould.* Common, living, at low tide, in Malaspina Inlet, Strait of Georgia; in Discovery Passage, between Seymour Narrows and Elk Harbour; in Johnstone Strait, the Goletas Channel, and Queen Charlotte and Quatsino Sounds.

BITTIUM MUNITUM. (=*Cerithiopsis munita*, Carpenter.) Queen Charlotte Sound at station No. 12, ten fine and mostly living specimens. The writer is indebted to Mr. W. H. Dall for the suggestion that this shell is probably a Bittium rather than a Cerithiopsis, and that the *Cerithiopsis columna* of Dr. Carpenter is only an abnormal form of it.

LITTORINA SITCHANA, *Philippi.* A common littoral species throughout the district. A few specimens of it were dredged in Discovery Passage, at station No. 7. The late Dr. Jeffreys regarded this shell as only a local variety of the European *L. rudis.*

LITTORINA SCUTULATA, *Gould.* With the preceding species, but apparently not quite so common.

LACUNA SOLIDULA, *Loven.* (=*L. carinata*, Gould.) A few living specimens were taken at or near low water in Alert Bay, B. C., and it was dredged living, but in very small numbers, in Discovery Passage at station No. 8, and in Queen Charlotte Sound at stations Nos. 12 and 15. Dr. Jeffreys was of the opinion that this shell is a variety of *L. divaricata*, Fabricius (=*L. vincta*, Montagu), of northern Europe.

BARLEEIA SUBTENUIS, *Carpenter.* Queen Charlotte Sound at station No. 12, one living specimen.

SURCULA PERVERSA, *Gabb.* Queen Charlotte Sound at station No. 16, one large, living specimen, an inch and three-quarters in length, and another small but living shell; and station No. 17, an immature but living specimen.

This large and remarkable species, which is invariably sinistral, was previously dredged alive by Mr. James Richardson in from thirty to seventy fathoms in the Strait of Georgia. In the young state the test is nearly smooth and covered by a very pale, greenish-grey epidermis, and the body whorl is encircled by two spiral bands of a faint reddish-brown tint, one next to the suture and the other a little below the middle.

BELA FIDICULA, *Gould.* Johnstone Strait at station No. 10, four specimens; Queen Charlotte Sound at stations Nos. 14 and 16,—one living specimen at the first, and two full-grown, living shells at the second.

BELA TABULATA. (=*Mangelia tabulata*, Carpenter.) Queen Charlotte Sound at station No. 16, two specimens. Perhaps only a variety of the last named species.

BELA VIOLACEA, *Mighels*, var. (*Teste* Dall.) Queen Charlotte Sound at station No. 14, one living specimen.

TURBONILLA VANCOUVERENSIS. (*Chemnitzia Vancouverensis*, Baird.) Discovery Passage at station No. 7, one living shell; Johnstone Strait at station No. 10, one living shell; Queen Charlotte Sound at station No. 13, eight living examples of a white-shelled variety of this species.

ODOSTOMIA SITKENSIS, *Dall.* Strait of Georgia at station No. 2, one living and full-grown specimen.

EULIMA POLITA, *L.* Living and frequent in the Strait of Georgia at stations Nos. 5 and 6, in Discovery Passage at stations No. 7 and 8, in Johnstone Strait at station No. 10, in Queen Charlotte Sound at stations Nos. 14, 15 and 17, and in Quatsino Sound at station No. 20.

About fifty living specimens of this shell were dredged by Dr. Dawson, and the only observable difference between them and authentic English examples of *E. polita* is one of size, the former attaining frequently to a length of thirteen millimetres, while the latter are sometimes as much as sixteen mm. long. Smaller specimens of the same shell were dredged by Mr. Richardson in the Strait of Georgia in 1875, and these were referred by the writer to the *E. micans* of Carpenter, in "Canadian Naturalist," Vol. VIII, N. S.; but Dr. Carpenter himself regarded *E. micans* as "perhaps a smaller variety of the European *E. polita*."

EULIMA INCURVA, *Renieri* (=*E. distorta*, auct.) With the above, but not nearly so common, at stations Nos. 6, 10 and 14. Two living specimens were also taken at low tide in Discovery Passage, between Seymour Narrows and Elk Harbour, and one at low tide in the Goletas Channel.

SCALARIA INDIANORUM, *Carpenter.* One fine, living adult specimen of this species, measuring nearly an inch and a half in length, was dredged in Discovery Passage at station No. 7.

CANCELLARIA CIRCUMCINCTA, *Dall.* Johnstone Strait at station No, 10, one living and adult specimen; Queen Charlotte Sound at station No. 12, a series of about twenty living specimens, and at station No. 13, one full-grown living shell.

ADMETE VIRIDULA, *Fabricius.* Queen Charlotte Sound at stations Nos. 12 (three living specimens), 17 (two living specimens), and 18 (one living specimen). Most of these belong to the short-spired variety of the species, to which Verkruzen has given the name *undatocostata.*

TRICHOTROPIS CANCELLATA, *Hinds.* Dredged more or less abundantly, alive, in the Strait of Georgia at station No. 5, in Discovery Passage at station No. 7, in Johnstone Strait at station No. 10, and in Queen Charlotte Sound at stations Nos. 12, 13, 15, 16, 17 and 18. Taken living also, in some numbers, at low water in Johnstone Strait and the Goletas Channel.

VELUTINA LÆVIGATA, *L.* Discovery Passage at station No. 8, one living specimen.

NATICA CLAUSA, *Broderip and Sowerby.* Taken sparingly, but alive and in some cases of considerable size, at low water, on the north shore of the Strait of Georgia; in

Johnstone Strait; at Beaver Harbour, Vancouver Island; on the east side of Queen Charlotte Sound, and on the north and north-west coast of Vancouver Island between Nahwitti Bar and Quatsino Sound. Dredged also, alive, but in small numbers, in the Strait of Georgia at station No. 5, in Discovery Bay at station No. 7, and in Queen Charlotte Sound at stations Nos. 12 and 17.

LUNATIA LEWISII, *Gld.* Low tide, entrance to Malaspina Inlet, one specimen.

LUNATIA PALLIDA? *Broderip and Sowerby.* Queen Charlotte Sound at station No. 17, two dead and imperfect shells.

TRITON (PRIENE) OREGONENSIS, *Redfield.* Low tide in Johnstone and Broughton Straits, in the Goletas Channel, and on the east side of Queen Charlotte Sound, but apparently not very common. Dredged, living and adult, but in very small numbers, in Johnstone Strait at station No. 10, and in Queen Charlotte Sound at stations Nos. 11 and 12. This shell is possibly only a local variety of the *Triton cancellatus* of Lamarck, from South America.

MARGINELLA (VOLUTELLA) PYRIFORMIS, *Carpenter.* Low tide in the Goletas Channel; dredged also in Queen Charlotte Sound at station No. 12, and in Quatsino Sound at station No. 20. One adult, living shell of this diminutive species at each of these stations.

OLIVELLA BIPLICATA, *Sowerby.* Abundant, living, on the west or outer coast of Vancouver Island.

OLIVELLA BÆTICA, *Carpenter.* Strait of Georgia at stations Nos. 2 (frequent) and 5 (very abundant), also in Discovery Passage at station No. 7, and in Queen Charlotte Sound at station No. 16. Living, and apparently not uncommon, at each.

CHRYSODOMUS LIRATUS, *Martyn.* Queen Charlotte Sound, at station No. 12, two living but very young specimens, with the mammillated apex beautifully preserved; at station No. 16, one half-grown and dead specimen; and at station No. 17, two fine adult specimens (one living), with a short spire to the shell and an unusually inflated or globose body whorl.

CHRYSODOMUS DIRUS, *Reeve.* (Sp.) Abundant, living, at low water at the entrance to Malaspina Inlet and on the north shore of the Strait of Georgia; in Discovery Passage, between Seymour Narrows and Elk Harbour; in Johnstone and Broughton Straits; in the Goletas Channel, and on the east side of Queen Charlotte Sound. Dredged, but in small numbers, in Discovery Passage, at station No. 7. The generic position of this species is uncertain, as the animal has not yet been described. The shell does not look like that of a Chrysodomus or Sipho. Tryon places it in the genus *Euthria*, but that course is not free from objections.

SIPHON VERKRUZENI, *Kobelt.* Queen Charlotte Sound at station No. 17, associated with *Neptunea lirata* and other rare species; one large, dead shell, but in excellent condition. Mr. Dall, to whom the writer is indebted for the identification of this specimen, writes that it had previously been found in Norway and in Behring Sea and Strait, but that the present is the most southerly locality yet reported for it.

BUCCINUM POLARE (*Gray*), *var.* COMPACTUM, *Dall.* At the same station as the species last mentioned ; one adult but dead shell, in good condition. This species was collected by Mr. James Richardson, at low water, near Victoria, Vancouver Island, in 1875.

NASSA (TRITIA) MENDICA, *Gould.* Strait of Georgia at station No. 5, alive and plentiful; Johnstone Strait at station No. 10, one living specimen ; Queen Charlotte Sound at station No. 12, several living shells ; and Quatsino Sound at station No. 20, ten living specimens.

ASTYRIS CARINATA (*Hinds*), *var.* HINDSII. (=*Columbella Hindsii*, Reeve.) Low tide in the Goletas Channel, one living specimen. In this species the nucleus of the operculum is said to be subcentral, or " somewhat more within the margin " than it is in that of *Nitidella Gouldii.*

NITIDELLA GOULDII, *Carpenter.* Strait of Georgia at station No. 2, two living specimens, and at station No. 5, abundant and living ; Quatsino Sound at station No. 19, three living specimens.

This shell has been separated from the preceding species, both generically and specifically, mainly upon minute differences in the opercula, the nucleus of the operculum of *N. Gouldii* being stated to be nearly marginal. Mörch, Dall and Fischer, however, assert that in the Columbellidæ the operculum is so variable that it does not afford a good character for the discrimination of genera or species, and Tryon, in his "Manual of Conchology," places *N. Gouldii* among the synonyms of *Columbella carinata.*

AMPHISSA CORRUGATA, *Reeve.* Common, living, at low tide, at the entrance to Malaspina Inlet ; in Race Passage and other localities in Johnstone Strait ; in the Goletas Channel, and in Queen Charlotte and Quatsino Sounds. Dredged also, alive and in some numbers, in the Strait of Georgia at station No. 5, and in Queen Charlotte Sound at stations Nos. 15, 16, 17 and 18.

PURPURA CRISPATA, *Chemnitz.* (=*P. lactuca*, Eschscholtz.) Extremely abundant and very variable in size, shape, sculpture and colour, living at or near low water mark, on the north shore of the Strait of Georgia, in Discovery Passage, in Johnstone and Broughton Straits, in the Goletas Channel, on the east side of Queen Charlotte Sound, and at the entrance to Quatsino Sound. Dredged also abundantly, alive, in Discovery Passage at station No. 7, and in very small numbers in Johnstone Strait at station No. 10, and in Queen Charlotte Sound at station No. 16.

PURPURA LIMA, *Martyn.* (=*P. canaliculata*, Duclos.) At low water throughout the district, associated with the preceding, of which Von Martens and others regard it as only a local variety. It did not, however, occur at any of the stations where the dredge was used.

PURPURA SAXICOLA, *Valenciennes.* Queen Charlotte Sound, at low tide, five adult, living shells of a variety in which the interior of the aperture and part of the columella is stained dark brown, while the former is margined exteriorly by a band of pale straw colour. Von Martens and other writers regard this shell as a mere variety of *P. lima*, Martyn.

OCINEBRA LURIDA, *Middendorf.* Low tide in Johnstone Strait, one living, adult specimen; Queen Charlotte Sound at station No. 13, an immature and dead shell.

OCINEBRA INTERFOSSA, *Carpenter.* Living, at low tide, but by no means common, in Johnstone Strait and the Goletas Channel; on the east and north-west coast of Vancouver Island, from Nahwitti Bar to Quatsino Sound, and at the entrance to Quatsino Sound. One adult, living specimen was dredged at station No. 20.

CEROSTOMA FOLIATUM, *Gmelin.* Fine and frequent, living, at low tide, at Twin Island and the entrance to Malaspina Inlet, in the Strait of Georgia; in Johnstone and Broughton Straits; in the Goletas Channel, and on the east side of Queen Charlotte Sound. Dredged also, living and adult, in Discovery Passage at station No. 7.

TROPHON ORPHEUS, *Gould.* (=*T. Stuarti*, E. A. Smith.) Queen Charlotte Sound, at station No. 14, an immature, living shell, nearly an inch and a half long, with the varices prolonged behind into semitubular or deeply grooved, long, spiny frills, which curve lightly backward; at station No. 16, a living, adult shell, fully two inches long; and at station No. 18, a beautifully preserved living specimen, an inch and a quarter in length, with the spinose frills prolonged to an unusual length behind.

TROPHON CLATHRATUS, *L.* (=*T. multicostatus*, Eschscholtz.) Low water in Johnstone Strait, one adult, living specimen. A similar, but slightly larger one was dredged in Queen Charlotte Sound at station No. 12, and another at station No. 16.

TROPHON TENUISCULPTUS, *Carpenter.* (=*T. subserratus*, Sowerby.) Not uncommon, alive, at low tide, on the north side of the Strait of Georgia, in Seymour Narrows, and in the Goletas Channel. A few living specimens, also, were dredged in Discovery Passage at station No. 7, in Johnstone Strait at station No. 10, in Queen Charlotte Sound at stations Nos. 12, 16, 17 and 18, and in Quatsino Sound at station No. 19.

The largest specimens collected are a little more than an inch and a half in length. When examined with an ordinary simple lens, the whole surface of the shell of this species is seen to be almost covered by densely-crowded, minute, crenate and squamose raised lines of growth, which cross the spiral grooves and ridges and are superimposed upon the varices. The types of *T. tenuisculptus* are from the Pleistocene deposits at San Diego, but the shell is by no means uncommon in a living state on the coasts of Vancouver and the Queen Charlotte Islands.

CEPHALOPODA.

OMMASTREPHES SAGITTATUS, *Lamarck.* (Sp.) Three specimens of a squid, which correspond very well with Tryon's description and figures of this species in the first volume of his "Manual of Conchology," were collected at low water in Victoria Harbour, Vancouver Island.

The following is a supplementary list of fresh-water and land shells, fishes (marine), batrachians, ophidia, birds and mammals collected by Dr. Dawson and Mr. Dowling in the same district and season:—

Fresh-Water Shells.

Margaritana margaritifera, *L.* Small streams entering Malaspina Strait, on the mainland side, four small specimens.

Land Shells.

Selenites Vancouverensis. (=*Helix Vancouverensis*, Lea.) Harbledown and Pender Islands, in Johnstone Strait; and Malcolm Island, in Broughton Strait; a few living examples at each of these localities. Quatsino Sound, one dead and bleached shell.

Ariolimax Columbianus? *Gould.* Malcolm Island, Broughton Strait, three specimens in alcohol. These have not been dissected, and therefore may possibly be *A. Californicus*, Cooper.

Mesodon Columbianus, *Lea.* Taken sparingly on Harbledown and Pender Islands, with *Selenites Vancouverensis.*

Aglaia fidelis, *Gray.* North point of Texada Island, three living and six dead; entrance to Malaspina Inlet, one alive; and False Bay, Lasqueti Island, one alive; Growler Cove, Broughton Strait, one alive and one dead.

Fishes.

Merlucius productus, *Ayres.* Merluccio. Off Gabriola Island, in the Strait of Georgia. In this fish the scales on the sides of the body, which have been described as very small, are really comparatively large and measure six millimetres by four. They are, however, very easily rubbed off.

Gadus proximus, *Ayres.* Pacific Tom Cod. Caught in Alert Bay, Cormorant Island, at station No. 14.

Liparis pulchella, *Ayres.* Taken by the dredge at a depth of thirty fathoms in Queen Charlotte Sound.

Sebastodes mystinus, *Jordan and Gilbert.* Black Rock-Fish. Caught in Queen Charlotte Sound at station No. 12.

Anoploma fimbria, *Pallas.* Coal Fish. Taken at Broughton Strait, near Helmken Island.

Ammodytes personatus, *Girard.* Pacific Sand Launce. Alive near shore at Beaver Harbour, Vancouver Island.

Siphostoma Caiforniense, *Storer.* Big Pipe-fish. Two rather small specimens of this species were collected in the Strait of Georgia.

CHIMÆRA COLLIÆI, *Bennett.* "Rat-fish" or "Elephant Fish" of American icthyologists, but according to Dr. Dawson known locally as the "Silver Dog Fish." Queen Charlotte Sound at station No. 14, one adult male. A similar specimen was collected by Dr. Dawson in 1878, in deep water off the Queen Charlotte Islands.

BATRACHIA.

DIEMYCTYLUS TOROSUS. (=*Triton torosus*, Eschscholtz, and *Taricha torosa*, Gray.) The Warty Salamander. Texada Island, in the Strait of Georgia, and Coal Harbour, Quatsino Sound,—one specimen at each of these localities.

OPHIDIA.

EUTAINIA PICKERINGII, *Baird and Girard.* Pickering's Garter Snake. Oyster Bay, near Comox, one specimen two feet and three-quarters of an inch in length; and Georgina Point, Malaspina Inlet, one specimen not quite two feet long.

BIRDS.

BRACHYRHAMPHUS MARMORATUS, *Gmelin.* (Sp.) Marbled Guillemot. Northern end of Vancouver Island, two specimens.

PODICEPS CORNUTUS (*Gmelin*) *Latham.* Horned Grebe. Two young specimens of this species were shot at Growler Cove, Johnstone Strait, and one equally young at Farewell Harbour, Queen Charlotte Sound.

PODICEPS GRISEIGENA? *Boddaert.* Red-necked Grebe. A young grebe which may be referable to this species was shot in Broughton Strait.

CHROICOCEPHALUS PHILADELPHIA (*Ord*) *Lawrence.* Bonaparte's Gull. False Bay, Lasqueti Island, one immature specimen.

LARUS (BLASIPUS) HEERMANNI, *Cassin.* White-headed Gull. Malcolm Island, Broughton Strait, one not quite adult specimen.

LARUS GLAUCESCENS, *Lichtenstein.* Glaucous-Winged Gull. Cullen Harbour, Queen Charlotte Sound, one nearly adult specimen.

OCEANODROMA FURCATA, *Gmelin.* (Sp.) Fork-tailed Petrel. Goletas Channel, north end of Vancouver Island, one specimen.

GRACULUS DILOPHUS, (*Swainson*) *Gray.* Double-crested Cormorant. Blunden Harbour, Queen Charlotte Sound; two specimens, both devoid of crests but with twelve feathers in the tail.

OIDEMIA PERSPICILLATA (*L.*) *Fleming.* Surf Scoter. Comox Harbour or Port Augusta, Vancouver Island, one adult male.

OIDEMIA AMERICANA, *Swainson.* American Black Scoter. False Bay, Lasqueti Island, Strait of Georgia, one adult male.

HISTRIONICUS TORQUATUS (*L.*) *Bonaparte.* Harlequin Duck. One adult male of this species, in fine plumage, was shot on Lasqueti Island, at False Bay; and a young male at Mittlenach Island, in the Strait of Georgia.

MARECA AMERICANA (*Gmelin*) *Stephens.* American Widgeon. Beaver Cove, Broughton Strait, a young male.

NETTION CAROLINENSIS (*Gmelin*) *Kaup.* Green-winged Teal. Blunden Harbour, Queen Charlotte Sound, one young male.

ARDEA HERODIAS, *L.* Great Blue Heron. A young bird of this species was shot in Cullen Harbour, and a similar one in Blunden Harbour—both in Queen Charlotte Sound.

LOBIPES HYPERBOREUS (*L.*) *Cuvier.* Northern Phalarope. Fresh Water Bay, Queen Charlotte Sound, one specimen.

STREPSILAS MELANOCEPHALUS, *Vigors.* Black Turnstone. Forster's Island, Queen Charlotte Sound, three specimens.

HALIAETUS LEUCOCEPHALUS (*L.*) *Savigny.* Bald Eagle. Johnstone Strait, one young specimen.

COLAPTES MEXICANUS, *Swainson.* Red-shafted Flicker. Comox, Vancouver Island, one specimen.

CERYLE ALCYON (*L.*) *Boie.* Belted Kingfisher. Cullen Harbour, Queen Charlotte Sound, two males and one female.

CYANURA STELLERI (*Gmelin*) *Baird.* Steller's Jay. Comox, Vancouver Island, two specimens.

MAMMALIA.

SCIURUS HUDSONIUS, *Pallas*, var. Red Squirrel. Comox, Vancouver Island; one specimen, which differs only from the eastern form of the species in being a little smaller and not so distinctly rufous on the back.

PHOCA VITULINA, *L.* Harbour, Hair, or Leopard Seal. One specimen of the North Pacific variety of the Harbour Seal was shot in Broughton Strait. The species may be readily distinguished from all the other earless seals of both coasts of North America by the oblique implantation of its molars.

MUSTELA AMERICANA, *Turton.* Sable. Pine Marten. Johnstone Strait, one specimen.

CANIS LUPUS, (*L.*) *Wolf.* A large red wolf was shot near Cullen Harbour; and a small grey and black variety at Knox Bay, in Johnstone Strait.

X.—*On the Glaciation and Pleistocene Subsidence of Northern New Brunswick and South-Eastern Quebec.*[1] *By* R. CHALMERS.

(Communicated by Dr. George M. Dawson, May 27, 1886.)

The surface geology of Eastern Canada presents a number of interesting problems for investigation, some of which have given rise to considerable discussion. The two most important of these, perhaps, are the glaciation, whether by land ice or icebergs, or both, and the oscillations of level the region underwent during the Post-Tertiary period. This paper is intended as a brief contribution towards the elucidation of these questions.

Among a large number of geologists in America the glacier theory, with, perhaps, some modifications, is accepted. This theory explains the glacial phenomena of Eastern Canada and the New England States by supposing a thick sheet of ice of early Post-Tertiary age to have accumulated on the surface of the country, which, slowly moving southward from the Laurentide Mountains, crossed the St. Lawrence valley, over-riding the Notre Dame Range, passing thence down the Atlantic slope towards the ocean, striating the rocks and transporting masses of debris in its course, such as boulder-clay, erratic blocks, etc. Its general adoption is, perhaps, due principally to the fact that most of the striæ on both sides of the mountain range referred to, as well as on the south-east slope of the Laurentides, have approximately the same course, that is, they trend nearly south-east and north-west, or about at right angles to the axis of the Notre Dame Range. But the theory has other features to recommend it, being comprehensive and grand, and apparently at once solving all the problems pertaining to the glaciation of the region. Observations made by Sir W. Dawson in the St. Lawrence valley for many years, however (see his "Notes on the Post-Pliocene Geology of Canada," contributed to the "Canadian Naturalist," in 1872, and also "Acadian Geology," 3rd edition, 1878), led him to adopt a different conclusion, and he has long contended against the above view. In the course of his investigations, he ascertained that drift-ice (icebergs, coast ice, etc.) had been transported up, and probably down, the St. Lawrence valley during the ice age, the chief abrasion and denudation having been apparently caused by a south-westward flow of these. He also found evidences of local glaciers having debouched into this valley from the north, following the courses of the Saguenay and Murray Bay Rivers, etc.; and that the Pleistocene subsidence of the region had been as much as 470 feet below the present sea level in some places, especially in the vicinity of Montreal. Boulders of Laurentian rocks, it was also observed, had been drifted up and down the valley. These facts seemed conclusive against the theory of a glacier having moved across the St. Lawrence valley south-eastwardly from the Laurentides, pur-

[1] The term "Pleistocene" is here employed in the sense in which it is used in Dr. Archibald Geikie's Text Book of Geology, 2nd edition; and as equivalent to the term "Post-Pliocene" of Sir W. Dawson's Acadian Geology, 3rd edition, to distinguish the subsidence under consideration from that which took place in the Recent or Prehistoric period.

suing a course over the eastern part of the Appalachians. But the correspondence in the courses of the striæ along the Notre Dame Range referred to above (see "Geology of Canada," 1863, list of glacial grooves, p. 890, Nos. 123 to 131, and 138), with those on the higher levels on the north side of the St. Lawrence, lent countenance to the view of Sir William Dawson's opponents, on the generally accepted supposition that all ice-movements were from north to south. Moreover, it was also contended by the advocates of extreme land glaciation that the supposed ice-mass which occupied the St. Lawrence valley was of sufficient thickness to cause the bottom to move up the valley, while the upper portion pursued the course indicated by the striæ just quoted, thus at once producing all the phenomena observed. But evidence which I shall adduce in this paper, regarding the glaciation of the northern slope of the Notre Dame Mountains, and which can probably be applied to the explanation of all glacial phenomena along the north-west side of the Green Mountain Range as well, renders it now apparent that local glaciers moved northward from their summits, or rather from the adjacent watershed, into the hydrographical basin of the St. Lawrence. And further, this mountain range shed the ice, or snow and ice, which gathered upon it, in both directions; and thus the approximate parallelism of the courses of the striæ on the north and south sides, is due to the fact that the ice gravitated down the slopes at about right angles to the main axis of the chain. This evidence, together with the proofs of a north-west and south-east striation on the lower levels, first noted by Sir W. Dawson and already referred to, seems to leave little doubt that the mode of glaciation, in the drainage basin of the St. Lawrence at least, was by local glaciers descending into it from the north and south, and by drift-ice.

Before presenting a statement of investigations made on the south side of the Lower St. Lawrence during a brief visit to that interesting region in the summer of 1885, I shall give a summary of the facts respecting the glaciation of New Brunswick, and more especially of the Baie des Chaleurs district.

From preliminary observations made in that province, it appears that there have been two principal ice-movements there during the early Post-Tertiary period. A low watershed traverses it from the extreme north-west, in a south-easterly direction, to the Isthmus of Chiegnecto. This watershed has shed the ice which accumulated on the surface of the country during the ice age northward and southward, or, speaking more correctly, north-eastward and south-eastward, somewhat as it now does the drainage waters, the ice on the south side moving towards the depression occupied by the Bay of Fundy, while on the north it flowed towards the bays and straits connected with the Gulf of St. Lawrence.

The courses of the striæ met with in northern New Brunswick, particularly in the Restigouche valley and along the south side of the Baie des Chaleurs, are given in the Annual Report of the Geological Survey of Canada for 1885 (Report GG.) They show the general trend of the ice-movement to have been about south-eastward in the Upper St. John valley, and eastward and north-eastward, in the Baie des Chaleurs basin and along the Gulf shore. On the north side of the Baie des Chaleurs, however, the striæ have a more southerly bearing, as will be seen from the following sets discovered during the summer of 1885:—(1) Near Maguasha Point, course S. 68° E.[1] (2) On the east side of Nouvelle River, at the upper slope of the valley, in two or more places, viz., (*a*) at Parker

[1] All the bearings in this paper are referred to the true meridian.

Settlement, course S. 24° E., (*b*) on road to St. Louis Mountain settlement, course S. 44° E.; (3) at Black Cape, in several places, striæ and *roches moutonnées*, course S. 42° E. to S. 45° E.; (4) at Port Daniel, *roches moutonnées* and grooves, course S. 44° E.; and (5) between Port Daniel and Point Maquereau in numerous places, S. 44° E. The absence of striæ in the coast district between Black Cape and Port Daniel is, perhaps, chiefly owing to the crumbling nature of the Lower Carboniferous sandstones which skirt it. These have not retained ice-marks, but boulder-clay is abundant, occurring in thick masses between Le Blanc and Little Bonaventure Rivers and elsewhere. It is here composed of the debris of the underlying rocks, with boulders from the Silurian and other formations in the interior interspersed through it.

Coördinating all the facts relating to striæ in the Baie des Chaleurs basin, it appears that the local glacier, which occupied its western end, drew tributary glaciers from the valleys of the Restigouche, Scaumenac, Nouvelle, Cascapedia, etc. Those from the north side, coalescing with the main glacier of the Restigouche Valley pushed it over on the low-lying slopes on the south side of the bay, causing it to pursue a course diagonally across the coast area, or in some places nearly parallel to the shore line, as far east as Belledune Point. To the east of this, however, the glaciers seem to have slid down more directly into the bay, both from the north and from the south.

The evidence which I have to present, showing a northward movement of ice on the southern slope of the St. Lawrence valley, is chiefly the result of observations made in the district between Rivière du Loup and Metis. As already intimated, it is important in its bearing on the general question of the glaciation of eastern Canada, and therefore I shall give the facts in some detail and in the order in which they came under notice, together with the data respecting the Pleistocene subsidence of the same region.

(1) At Rivière du Loup, no striæ were observed. Terraces occur at different elevations up to 350 feet or more,[1] the Intercolonial Railway Station being ?22½ feet high. In the valley lying between the railway station and Rivière du Loup village, in a terrace 212 feet high, a well was being sunk, in which the following deposits were seen in descending order:—(1) Twelve to fifteen feet of coarse, stony gravel, somewhat like boulder-clay in the bottom, owing to the fact that the materials have been partly washed down from an adjacent, crumbling, rocky slope; and (2) dark, sandy clay, of unknown depth, containing, in the upper part, shells of *Saxicava rugosa*, *Macoma Groenlandica*, *Mytilus edulis*, and a species of Leda or Yoldia.

(2) Along the road from Rivière du Loup to Cacouna village, a low ridge near the shore is seen to be highly glaciated, the agent producing the striæ having moved either up or down the valley, i.e., in a direction nearly parallel to the coast. Cacouna Station (263 feet high) stands on an extensive terrace, behind which others rise to a height of 345 feet. Fine blown sand occurs in the upper terrace, and great numbers of gneissic and granitic boulders, all well rounded, were seen along what must have formed an old shore line.

(3) At St. Arsène Station (277 feet high), an extensive terrace, continuous with that

[1] The heights given are above high tide level; those of the Intercolonial Railway stations were obtained from profiles in the office of the Railway Department, Ottawa, through the kindness of Mr. Collingwood Schreiber, Chief Engineer of Government Railways.

on which Cacouna Station (three miles distant) stands, extends back half a mile or more, and is bordered by narrow terraces rising to a height of 340 to 345 feet. In new openings made for telegraph poles near the station, marine fossils of the common species were found. Above the 345 feet contour line here, as at Cacouna, the surface appears to be more uneven; terraces were not observed; rolled, water-worn boulders are not so numerous; and the debris, generally speaking, is more angular.

(4) About half a mile west of Trois Pistoles Station (100 feet high), following the Intercolonial Railway; planed, grooved and striated rocks were seen in the bed of a stream, the direction of the striæ being N. 2° W. The grooves, some of which are one to two feet wide, and the finer striæ, are all parallel. The rounded faces look to the south. On the northward-sloping face of one of the larger bosses, however, other striæ were seen, having a course of S. 35° W., or N. 35° E. Whether the ice which produced the latter moved up or down the St. Lawrence valley, or was earlier, or contemporaneous, or later in date than that causing the south-to-north striation, could not be determined. No planing of surfaces was noticed, and these striæ have, to all appearance, been made by icebergs.

(5) A few rods to the east of Trois Pistoles Station, another small stream flows down the hill side. Just above the main road it falls over a ledge, forming a cascade. This ledge is also planed and striated in the direction of N. 10° W., the northern face descending abruptly, causing the cascade mentioned. Till rests on the surface of these planed rocks, containing boulders which appear to be derived chiefly from local rocks, but a few of granite and crystalline schist were also noted. On the road leading from Trois Pistoles Station to the back settlements, about a mile from the shore, rock bosses, 450 feet high, were seen, planed and grooved in a north-and-south direction, stoss-side distinctly to the south, and the north side broken off. Glacial striæ were observed in several places in the rear settlements up to an elevation of 800 feet. All the rock bosses and east-and-west ridges show the rounded faces invariably to the south. On a ridge in the third range of lots, striæ were found bearing N. 45° W. to N. 50° W., the difference between these and the courses near the shore being due to local inequalities of the surface. No evidence of a submergence beneath the sea was seen above the level of 345 to 375 feet. The terraces, up to that height, face the St. Lawrence, and an old shore line is traceable here. Below this level, well-rounded blocks of gneiss, syenite, granite, etc., evidently Laurentian, strew the surface in great profusion. Above it the boulders appear to be more angular, with fewer gneissic and granitoid ones, but a larger number belonging to local rocks. The general surface is also more uneven, and without those wide, flat expanses characteristic of sea bottoms.

(6) On the road leading from Trois Pistoles to St. Simon, glaciated surfaces were observed in several places, especially on the sides of the low ridges and bosses. Distinct striæ could not be found, but planing and grooving denote that the ice-movement was in nearly a northerly direction. At St. Simon Station (292 feet high) the upper margin of the marine beds was seen to the south, along the face of an escarpment at a height of about 345 feet. A clear distinction is here discernible between the deposits above and below that level, the former containing angular boulders and debris. At the height of 375 feet, however, there are indications of an old shore line here, as well as at Trois Pistoles, but the angular debris and steep face were seen for about thirty feet below that level in some places. The chief terrace at St. Simon is that on which the railway station stands.

(7) Along the road leading to the back settlements from Rimouski Station (67 feet high), terraces facing the St. Lawrence occur at elevations of 260, 330 and 367 feet. The 330 feet terrace is a wide one, in which marine fossils were found, while that at the 367 feet level is narrow and somewhat uneven. An old shore line is traceable at its upper margin, along which numerous boulders of gneiss, granite, etc., are seen; while above it the deposits have the usual subangular character, as far back as examined, up to an elevation of 625 feet. Glaciated rocks and *roches moutonnées* occur in several places, but no well defined striæ. The ice-worn sides were in all cases presented to the S. or S. W.

(8) At Bic, polished rocks occur half a mile west of the Intercolonial Railway Station (75 feet high), but without distinct striæ. The ice producing these, however, evidently moved up or down the St. Lawrence valley nearly in the direction of S. 50° W. or N. 50° E.

(9) St. Flavie Station (246 feet high) stands on an extensive terrace. The upper limit of the marine beds could not be distinctly traced here, although there appear to be high-water marks at the contour lines of 290 or 300 feet and of 340 or 350 feet. On the 340 feet terrace, numerous water-worn boulders of the usual kind occur. Behind St. Flavie Station, a ridge extending east and west is glaciated on the south side, but no distinct striæ were visible.

(10) No traces of marine beds were observed at St. Octave Station (561 feet high) nor at Little Metis Station (675 feet high), the ground being uneven and rolling. Looking down from the Intercolonial Railway track, between these two stations, however, the great marine plain, 200 to 300 feet below, can be seen skirting the St. Lawrence and extending up and down the valley.

In the list of glacial grooves, in the "Geology of Canada," 1863 (p. 890), already quoted, the following sets are recorded, which may be correlated with those just described Their courses are all referred to the true meridian.

1. On Kempt road, near Metapedia Lake		S. 80° E.
2. At Temiscouata Lake, west shore		S. 54° E.
3. " south shore		S. 52° E.
4. " in three places near the last	(1)	S. 66° E.
	(2)	S. 48° E.
	(3)	S. 27° E.
5. At Trois Pistoles	S. 32° E.	
[but the true course is probably the reverse		N. 32° W.]
6. On Temiscouata road, in five places, with courses varying from	S. 44° E. to	S. 64° E.
[but true courses probably	N. 44° W. to	N. 64° W.]
7. In the Eastern Townships, at St. Armand, Sutton, Orford and Sherbrooke, striæ with courses varying from	S. 36° E. to	S. 61° E.
[but the true course of these may also be	N. 36° W. to	N. 61° W.]

The striæ numbered 1, 2, 3 and 4 are on the south side of the watershed of the Notre Dame Range, and were doubtless, caused by ice moving southward; but those included under numbers 5, 6 and 7 may have been produced by northward-moving ice, similarly to the striæ met with between Rivière du Loup and Metis.[1] If such is really the case,

[1] During the summer of 1886, Prof. L. W. Bailey discovered striæ and transported boulders in the northern part of the Lake Temiscouata basin showing a northward ice-movement (see Science, viii. 412.)

the facts would indicate that, as already stated, the watershed here was occupied by ice which moved down the slopes, mainly following the drainage channels. It is probable, however, that the watershed was nothing more than a gathering ground for the snow and *névé* which, after motion began, became converted into local glaciers. My investigations in New Brunswick have shown that certain portions of the interior were either covered by snow only during the ice age, or if by ice, that it was motionless, or nearly so, as the rock-surface in places has escaped abrasion. It is only reasonable to infer that a similar condition of things prevailed in South-Eastern Quebec; and hence it appears to have been chiefly along the valleys, and on the slopes and marginal areas that the principal work of glaciation was effected.

In regard to the Pleistocene subsidence, it will be seen that the facts point to a downward movement of the land in the Lower St. Lawrence of 345 to 375 feet below the present high tide level. Above the 375 feet contour line, the uneven character of the surface, the general absence of foreign boulders and the more angular forms of such as are met with, support the conclusion that the submergence did not exceed that limit.

In the Baie des Chaleurs basin, however, a careful examination failed to detect any evidence of a subsidence greater than 180 to 200 feet below the existing sea level. The data on which this conclusion is based will be found in my report to the Director of the Geological Survey of Canada, Annual Report, Vol. I, 1885, and in that about to be published in Vol. II, 1886.

All the evidence at hand goes to show that the downward movement of the land in the Pleistocene period was greater, with reference to the present sea level, north of the Appalachian Mountains than south of them. The facts, it must be admitted, are extremely fragmentary, but it would appear that the upper limit of the subsidence does not present the form of a regular curve from south to north, nor perhaps in any other direction. Each of the great Palæozoic basins seems to have been unequally affected by the oscillatory movement, and, moreover, it is probable that the changes of level have been unequal also in different parts of these areas.

The results of observations thus far made, as regards the subjects under discussion in this paper, may therefore be summarized as follows:—

(1) The glaciation of South-Eastern Quebec and Northern New Brunswick in the Post-Tertiary age was effected largely by local glaciers, which moved northward and southward from the highest land or watershed adjacent to the Notre Dame Mountains, this watershed forming a gathering ground for the snow and *névé* which sent local glaciers down the valleys and along the lines of drainage into the St. Lawrence valley on the one hand, and the Baie des Chaleurs, Gulf of St. Lawrence, and St. John valley, on the other.

(2) The Baie des Chaleurs and St. Lawrence estuary must have been, at least, partially open during the period of extreme glaciation, the former east of Belledune and Bonaventure Points; but how far westward the St. Lawrence basin was open, has not yet been determined.

(3) The surface of the rocks along the south side of the St. Lawrence below the 345 feet contour line has been, in many places, striated by bodies of ice, which moved up or down the valley, or perhaps both ways, and which appear certainly to have been floating ice or icebergs, as shown by Sir William Dawson.

(4) The Post-Tertiary oscillations of the land were greater in the St. Lawrence than in the Baie des Chaleurs basin, the Pleistocene subsidence having been 345 to 375 feet below the existing high tide level in the former, while in Northern New Brunswick it did not exceed 200 feet.

XI.—*On the Cambrian Faunas of Cape Breton and Newfoundland.*

By G. F. MATTHEW, M.A.

(Read May 27, 1886.)

In connection with his work on the St. John group, the writer has examined material from the Cambrian Rocks of Cape Breton and Newfoundland. This material has proved to be of much interest in further extending, our knowledge of the distribution of the organisms of this early period, and a short notice of the species observed may therefore be acceptable. The chief points of interest in the remains from these more eastern localities are, the very full representation of the older or Paradoxides fauna in Newfoundland, and the presence of the later forms of the Olenus fauna in Cape Breton.

CAPE BRETON.—Through the kindness of Mr. J. F. Whiteaves of the Canadian Geological Survey, I have had an opportunity of examining the collection of Cambrian fossils made in Cape Breton, by the Survey officers. Some of the fossils in these collections are too imperfect to be determinable, and others are of a kind that do not indicate any special horizon in the Cambrian, but there are several lots from Mira River which are of greater value in this respect. The fossils found here belong to the upper part of the Olenus division of the Cambrian system; and the species observed were the following :—

Peltura scarabeoides, *Wahl.*
Sphærophthalmus alatus, *Boeck.*
Agnostus pisiformis, *Linn.*

There is also a small Lingulella, similar to one which characterizes the upper measures of the St. John group, and is allied to *Lingulella ferruginea*, Salt.; and also an Orthis, too imperfect for determination, but which appears to be similar to *O. lenticularis*, Dalm.

NEWFOUNDLAND.—Mr. J. P. Howley of the Geological Survey of Newfoundland sent to the writer, in 1885, a small collection of Cambrian fossils from several localities in the peninsula of Avalon. With the aid of these and the description of a number of species from Newfoundland, made some years ago by the late Mr. E. Billings and by Mr. J. F. Whiteaves, the writer has been able to classify imperfectly the Cambrian horizons existing in that island.

There are beds of Cambrian age on the Straits of Belleisle at the northern extremity of Newfoundland, but these are separated from those of the peninsula of Avalon by a wide interval of Pre-Cambrian rocks; and their fauna resembles that of the interior continental areas of Cambrian rocks: it is therefore not thought necessary to refer to them further in this paper.

The Faunas.

I.—Faunas of the Paradoxides Division.

Cambrian fossils are stated to occur in the slates near the city of St. John's, but the proof that these slates are older than those to be hereafter described, does not appear to be altogether satisfactory. The fossils contained in these slates are worm burrows, and a gasteropod, but these are not of such a kind as would establish an older horizon. In almost every country, the Cambrian system is found to begin with coarse sediments, containing a few, and these obscure, fossils; and the more characteristically fossiliferous beds which follow, may range any where from the Solva group to the equivalent of the highest Cambrian measures. No confidence, therefore, can be placed in these coarse or foliated beds with obscure fossils, as indicating any special horizon in the Cambrian system; and we are compelled to look upon the strata in Conception Bay as those which give us the first sure indication of measures which can be parallelled with known Cambrian horizons in other lands.

A.—*Horizon of* Agraulos strenuus.—The oldest fossils of this nature appear to be those of Topsail Head and Brigus, in Conception Bay, but these do not yet give sufficiently firm indications to make it clear that they are older than some other horizons mentioned hereafter.

Mr. Billings describes from these places the following species:—

Agraulos strenuus, *Bill.*
Iphidea (allied to *Iphidea bella*, Bill.)
Stenotheca paupera, *Bill.*

To these I may add the following:—

Paradoxides, Sp?
Selenopleura bombifrons, N. Sp. (see p. 156.)
Ptychoparia, Sp.
Straparollina, Sp?
Hyolithes Micmac, *Matt.*

The position of these fossils (i. e. the horizon) is still open to question, as the material is too meagre to give satisfactory results, and the range of the species elsewhere is not sufficiently known. *Agraulos strenuus* appears to correspond to a species which is present in Band *c* of Division 1, of the St. John group; but as one fossil is preserved in shale and the other in limestone, it is not quite certain that they are identical, since the conditions of preservation are not the same in the two localities. The first trilobite in the second list is also of uncertain value: it is a primitive form of the Paradoxides family, which has points of resemblance to *P. Kjerulfi* but differs in the form of the free-cheek and in other respects. *Selenopleura* is a genus which ranges through Bands *c* and *d* and has a still more extended range in Scandinavia. *Hyolithes Micmac*, in the St. John basin, is also found throughout Band *c*, and enters Band *d*. This species by its longitudinal striation appears to be related to *H. tenuistriatus*, Linnrs., of the Scandinavian measures, with a

similar stratigraphical position in the Cambrian system of Europe. We are therefore without sufficiently definite knowledge to fix absolutely the horizon of these limestone beds, by the contained fossils.

B.—*Horizon of the* CONOCORYPHINÆ.—In entering upon the discussion of this horizon, we stand upon more stable ground. The range of the genera, *Conocoryphe* and *Ctenocephalus*, in Scandinavia as in Acadia is well understood, and therefore, in the presence of these forms at Manuel River, near Topsail Head, we have, by their known vertical distribution, which is limited, a means of deciding, within certain fixed bounds, the age of the shales which contain them.

Mr. Whiteaves records from Manuel River the following species:—

Microdiscus punctatus, *Salt.*
M. Dawsoni, *Hartt.*
Agnostus Acadicus, *Hartt.*
Conocephalites (Liostracus ?) tener, *Hartt.*
C. (Conocoryphe) Baileyi, *Hartt.*
C. (Ptychoparia) Orestes, *Hartt.*

Of these species, the second, fourth and fifth do not range as high in the Cambrian rocks of the St. John basin (in New Brunswick) as the others; the assemblage may be regarded as corresponding to Band *c* of Division 1, of the St. John group. In the material sent to me by Mr. Howley from this locality, the following additional forms were found:

Paradoxides, Sp.
Agnostus gibbus (?), *Linrs.*
Agraulos socialis, *Bill.*
Hyolithes, Sp.

From the examples in this collection, it appears that *Agraulos socialis*, Bill., was much like *Arionellus difformis*, Ang., and had similar spines on the occipital ring and on certain segments of the thorax; but it differed from that species in the form of the glabella, which is conical. It appears to combine characters found in *A. difformis* and *A. ceticephalus*, Barr.

C.—*Horizon of* PARADOXIDES SPINOSUS (?)—I quote this species on account of the occurrence of *Paradoxides Bennettii*, Salt., at Branch, on the promontory between St. Mary's Bay and Placentia Bay. This species (*P. Bennettii*), discovered many years ago, was the first which drew attention to the interesting Primordial fauna of Newfoundland. The resemblance of this species to *P. Harlani*, Green, from Braintree, Massachusetts, has been pointed out by Prof. C. D. Walcott and others. I do not know what species are associated with this Newfoundland trilobite, but Mr. Billings has described, from the locality referred to above, *Agraulos affinis*. An Agraulos and a Ptychoparia have also been described from the Braintree locality, but as the species have not been recognized elsewhere, and the genera have a considerable range, we do not get much help from them towards fixing the exact horizon of *P. Bennettii*.[1]

[1] Since writing the above, a very large Paradoxides has been found in Band *c* of Division 1 of the St. John group, which is related to this species by the great width of the body, short genal spines, foliaceous pleuræ, etc.; it also has points of resemblance to *P. Harlani* and *P. Forchammeri*. If *P. Bennettii* holds the same stratigraphical position as the large species of the Acadian Cambrian rocks, it will be in close relation to the horizon of the Conocoryphinæ.

D.—*Horizon of* PARADOXIDES TESSINI.—A different and probably somewhat higher horizon appears to be indicated by the species found at Chapel Arm in Trinity Bay. Mr. Billings described from this place—

Paradoxides tenellus, *Bill.*
P. decorus, *Bill.*
Anopolinus venustus, *Bill.*
Obolella (Linnarssonia) misera, *Bill.*
Selenopleura communis, *Bill.*
Agraulos socialis, *Bill.*

In the pieces of limestone sent to me from this locality by Mr. Howley, I find in addition the following forms :—

Eocystites, Sp.
Agnostus lævigatus, *Dalm.*
A. punctuosus, *Ang.*, var.
Agnosti of three other species.
Microdiscus punctatus, *Salt.*

There are fragments of a Paradoxides, which, by its hypostome, suture, pleuræ, and pygidium is very like *P. Tessini*, Brong. This is probably the *P. decorus* of Billings.

The organisms from this locality are evidently a Menevian assemblage and equivalent to those of Band *d* in Division 1 of the St. John group.

E.—*Horizon of* PARADOXIDES DAVIDIS.—In a black, silico-calcareous rock from Highland Cove in Trinity Bay, sent me by Mr. Howley, there were abundant remains of a large Paradoxides. The most important characters of the species are represented by the posterior half of the centre-piece of the head shield, by the free cheeks, by the long cylindrical genal spines, and by the peculiar hypostome ; the outlines and aspect of the parts preserved agree exactly with those of examples from the Swedish Primordial beds, figured by G. Linnarsson.[1]

Associated with this species, at this locality, are the following :—

Centropleura Loveni, *Ang.* ? (Pygidium only.)
Agnostus punctuosus, *Ang.*, var.
A. brevifrons, *Ang.*
A. lævigatus, *Dalm.*
A. Acadicus (*Hartt*), *var.* declivis, *Matt.*

From the above lists of species, it will be seen that there is a fuller representation of the forms of Paradoxides in Newfoundland than is yet known from any other part of America, and a greater affinity also in the species of the faunas of the Paradoxides division to those of Europe.

II.—FAUNAS OF THE OLENUS DIVISION.

The species of the middle Cambrian appear to be inadequately represented in the Cambrian strata of Newfoundland. The measures are chiefly sandstones and flag-stones,

[1] De Undre Paradoxides lagren, Stockholm, 1883, Plate ii.

similar to the Lingula flags of Great Britain. Species found in these measures have been described by Mr. Billings. At Great Bell Island, in Conception Bay, the following were found:—

Eophyton Linnæanum, *Torell.*
E. Jukesi, *Bill.*
Arthraria antiquata, *Bill.*
Lingula Murrayi, *Bill.*
Lingullella (?) affinis, *Bill.*
L. (?) spissa, *Bill.*
Cruziana similis, *Bill.*

From Kelly's Island, near Great Bell Island, Mr. Whiteaves has described a pretty little Lingula under the name of *Lingula Billingsiana.*

No deep-water species has been reported from this portion of the Cambrian system in Newfoundland.

Descriptions of Species.

I.—AGRAULOS, Hawle and Corda.

Under Agraulos, Mr. Billings has described three species from the Paradoxides beds of Newfoundland; two of these differ considerably from the type of the genus as described by Corda and Barrande, and one of the two is so unlike the type, that it should be separated, as a subgenus, if indeed it is not worthy of more distinct recognition; the aberrant form Mr. Billings has named *A. strenuus.*

The two species which come nearer to the type of Agraulos are the following:—

1.—Agraulos socialis, *Billings.*

Fig. 1.—*Agraulos socialis,* Bill.—Narrow form.—Centre piece of the head shield and twelve segments of the thorax; the glabella is decorticated, and shows, on the mould, the furrows, which are only faintly marked on the outer surface of the test. Natural size. 1 *a.* Same seen in profile. 1 *b.* Same seen in front.

The following is Mr. Billings' description of this species:—"Head (without the moveable cheeks) semielliptical or conical, width at the base a little greater than the length, gently convex. Glabella conical and (including the triangular projection backward from the neck segment) about two-thirds the whole length of the head; neck furrows all across, but obscurely compressed; neck segment with a triangular projection backwards, terminating in a short, sharp spine. Fixed cheeks gently convex; front margin, sometimes with a portion in front of the glabella thickened. Eyes of moderate

size; are situated on a line drawn across the head at about the mid-length, distant from each other about the length of the head. Surface nearly smooth. In small, perfect specimens no trace of glabellar furrows can be seen, but in some of the large ones four or five obscure furrows are exhibited. The largest specimen seen is six lines in length and seven in width. It occurs at Chapel Arm, Trinity Bay."

In my examples, which are from Manuel River, the centre piece of the head shield is more broadly rounded in form than that represented in the woodcut in "Palæozoic Fossils" (Vol. II. Pt. 1, p. 71. f. 40), especially at the posterior angles. The proportions given by Mr. Billings agree with those of the examples from Manuel River, but the eyes are narrower and less prominent than shown in his figure. The following additional characteristics of this species may be given:—

The head is flat and the glabella outlined by only a faint dorsal furrow. The glabellar furrows are scarcely distinguishable on the outside of the test, but on the inner surface are more clearly seen; there are three principal furrows, of which the posterior is the longest, and is strongly arched backward as it approaches the axial line, and the anterior furrow is very short; but behind the main furrow of the three, there is a faint and shorter furrow whose course is more directly towards the axis of the glabella. The spine on the occipital ring projects backward far enough to cross the third ring of the thorax.

The thorax has twelve or more segments; the second, third and fourth rings of the rachis are narrow, the fifth and sixth are wider, and bear spines similar to that on the occipital ring; the rings behind those which carry the spines are broader and flatter than the anterior rings. The posterior margins of the pleuræ, especially of the anterior ones, have a sigmoid curve corresponding to the posterior margin of the head, and curve forward at their extremities; and each is grooved by a shallow sulcus extending from the anterior inner angle about two-thirds, or three-quarters, for a short distance diagonally toward the extremity of the pleuræ, and for the remainder nearly parallel to and near the anterior margin; but in the pleura behind the spined rings of the rachis, these sulci are very faint, and tend at their extremities to run toward the anterior margin of the pleuræ.

The surface of the test appears smooth, but under the lens is seen to be punctate with minute punctures of unequal size; the inner surface of the test is minutely pitted, and also has scattered pits of larger size.

There is a broad and a narrow form in this species. In the narrow form, represented in the figure, the glabella is nearly cylindrical, and as broad as long; and the rachis of the thorax at the spined rings is about one-quarter narrower than the lobes; in the broad form the glabella is considerably broader than long, and the rachis of the thorax at the spined rings is of the same width as the side lobes.

The length of the centre piece of the head shield from the apex to the point of the occipital spine, in the narrow form, is 11 millimetres, the width is 12 mm., and the height $2\frac{1}{2}$ mm. The length of the twelve segments of the thorax is 10 mm. and the width 12 mm. The whole length of the parts preserved is 18 mm.

Locality.—In the Cambrian gray shales at Manuel River, Conception Bay, Newfoundland.

This species is to be compared with *A. ceticephalus* rather than with *A. difformis* of the European Cambrian rocks, for, although it has a thickened and protruding anterior limb to the fixed checks, in its general form, its eyelobes and its posterior margin, it is akin to

the former; nevertheless, it bears slender spines on certain rings of the thorax after the manner of the latter species.

2.—Agraulos affinis, *Billings.*

Fig. 2.—*Agraulos affinis*, Bill.—Centre piece of the head shield. Mould of the interior of the test, showing the glabellar furrows more distinctly, and the occipital spine more acuminate than they appear on the outer surface of the test. Natural size. 2 *a*. Same seen in profile. 2 *b*. Same seen in front.

This species is too near the last to be readily distinguished, except by comparison of examples of the two species. Mr. Billings gives the following description of the species, but no figure:—

"This species is closely allied to *A. socialis*, and is of the same size, but differs in the following respects: the glabella is broader and, with the sides, gently convex. The eyes are somewhat nearer the sides of the glabella. The whole of the anterior portion in front of the glabella is convex. The dorsal furrows are more distinctly impressed all around the glabella. It occurs at Branch, St. Mary's Bay."

Besides the points of difference named by Mr. Billings, there are others which separate this species from the preceding. This has a shorter and more obtuse occipital spine, and the front of the shield is more strongly arched vertically; the course of the facial suture is more sinuous, and the eyelobe more prominent; the facial suture also is more broadly rounded, and curves in toward the posterior margin.

The length of the centre piece of the head shield is 11 millimetres, the width 13 mm., and the height about 4 mm.

The above notes are made on the type specimens of this species, now in the collections of the Geological Survey at Ottawa.

3.—Agraulos strenuus, *Billings.*

Fig. 3.—*Agraulos strenuus*, Bill.—Narrow form. Centre piece of the head shield. Inner surface. The glabellar furrows are not so sharply cut on the outside of the test, nor are the dorsal furrows. 3 *a*. Head shield seen in profile. 3 *b*. Same seen in front.

Mr. Billings described in the following terms a trilobite from the limestone of Brigus, in Conception Bay, under the above name:—

"Head (without the moveable cheeks) irregularly quadrangular; broadly rounded in front. Glabella rather strongly convex, conical, variable in its proportional length and width, either smooth or with several obscure impressions on each side, representing the

glabellar furrows; neck segment with a strong triangular projection backwards; neck furrow all across, but usually obscurely impressed. In some specimens the front of the head has a thick, convex, marginal rim, separated from the front of the glabella by a narrow groove; in others this rim is scarcely at all developed. The eyes, shown by the form of the lobe, appear to have been semiannular, and about one-third the length of the head. The surface appears to be smooth. The following are the dimensions of the best preserved specimen:—Length of the head, including the large posterior projection, six lines; width of the convex, marginal rim, one line; width of groove between the rim and the front of the glabella, one-third of a line; length of the glabella including the projection, five and two-thirds lines; width of the glabella at the posterior margin, three lines; width of the fixed cheek from the centre of the edge of the eyelobe to the side of the glabella, two lines. A line drawn across the head, at two and a quarter lines from the front margin, would pass through the anterior angles of the eyes. The length of the eye appears to be nearly two lines. As above remarked, this species varies somewhat in its proportional length and width, and hence, the dimensions above given would not be found to be exactly parallel in all the specimens. Occurs in the grey limestone of Topsail Head, and also in the pinkish limestone of Brigus, Conception Bay."

The woodcut in "Palæozoic Fossils" does not give an accurate representation of this species; the centre piece of the head is rather longer than wide, and has a long spine projecting backward from the occipital ring; there is a peculiar sharp angulation at the posterior margin; this has the appearance of a tubercle, and projects upward and backward. The eyelobes are long, heavy and much depressed at the extremities. The surface of the test appears smooth to the naked eye, but when viewed with a lens is seen to be minutely punctate.

There is a variety (or it may be another species) in the limestone at Brigus and Topsail Head, Conception Bay, which is a third larger than the dimensions given for this species by Mr. Billings; in this the glabella is longer and more cylindrical; and in the young of the variety the furrows of the glabella are more distinct and the cheeks are not so gibbous.

Both length and width of the centre piece of the head shield, in the examples received from Mr. Howley, are 13 millimetres, and the height 6 mm.; they are from the same localities as those studied by Mr. Billings.

This species departs considerably from the type of Agraulos, and should be the type of a subgenus; in the marked elevation of the parts of the head shield, the long eyelobes and the depressed anterior limb of the cheeks, it resembles Ellipsocephalus; in the short and direct posterior extension of the facial suture, it also resembles this genus; the prominent glabella, with depressed area behind the anterior margin of the head-shield, are points of resemblance to Liostracus.[1] If it is compared to Agraulos proper, it may be said to be more nearly allied to *A. difformis* than to *A. ceticephalus*, more especially to certain varieties of the former species found, by Prof. W. C. Brögger, in the Cambrian rocks of Norway.[2] I would suggest, for this Newfoundland species and the allied species in the St. John basin, the subgeneric name of *Strenuella*.

[1] Liostracus proper as described by Angelin, not as in Linnarsson's and Brögger's modifications of the genus.

[2] See Plate iv. figs. 3 and 4, "Om Paradoxides skifrene ved Krekling."

II.—SELENOPLEURA, Ang.

1.—Selenopleura communis, *Bill.*

Fig. 4.—*Selenopleura communis*, Bill.—Centre piece of the head shield. Natural size. 4 *a*. Same seen in profile. 4 *b*. Same seen in front.

In "Palæozoic Fossils" (Vol. II. p. 72), Mr. Billings describes the above species, but without any figure. I reproduce his description here, with figures in illustration of the species, drawn from the type specimen in the museum of the Geological Survey at Ottawa:—

"Glabella conical, convex, about two-thirds of the whole length of the head, about one-third wider at the neck furrow than at the front, on a side view considerably elevated above the fixed cheeks; neck furrow well defined all across; neck segment thickened in the middle and bearing a small tubercle. The fixed cheeks are strongly convex, but not so prominent as the glabella. The dorsal furrows are deeply defined all around the glabella. The front margin has a strong rounded rim, separated from the front part of the cheeks by a narrow, but distinct groove; between the groove and the front of the glabella there is a gentle depression, which separates the anterior angles of the fixed cheeks. The eyes are small, situated a little in advance of the mid-length of the head, distant from the side of the glabella a little less than half the length of the head, and are connected with the front of the glabella by an obscure ocular fillet. Surface with a few scattered tubercles, just visible to the naked eye, and between these numerous minute tubercles, only seen when magnified. The glabella exhibits traces of two or three obscure furrows on each side. Length of the largest head collected, five lines. Occurs at Chapel Arm, Trinity Bay, Newfoundland."

On comparison of the above figure and description with that of *Selenopleura Acadica*, Whiteaves, it will be seen that the two forms are closely allied, and it is not improbable that the latter may be a variety of Billings' species. The form of *Selenopleura Acadica* figured in my former paper is the broad form, but in the narrow form the resemblance is closer. The broad form (as preserved in the shales of the St. John Basin of Cambrian rocks) is easily distinguished from Mr. Billings' species by the complete separation of the anterior part of the fixed cheeks, and by the sharply upturned and narrow anterior marginal fold, and from both broad and narrow forms of the Acadian species, *S. communis* is distinguished by a difference in the granulation of the test.

This species of Billings may be compared with *Selenopleura brachymetopa*, Ang., from which, however, it differs in the form of the glabella and in other respects; it comes nearer to the *S. cristata* of Linnarsson; it differs, however, in the eyes being nearer to the glabella, as well as in having a test which is granulated only (not tuberculated). *S. parva* of the same author is also very near, but differs in the more sinuous anterior extension of the facial suture, the more gibbous cheeks, and the smoothness of the glabella; it is also a smaller species.

2.—Selenopleura bombifrons, N. Sp.

Fig. 5.—*Selenopleura bombifrons*, N. Sp.—Centre piece of the head shield. Magnified four times. 5 *a*. Same seen in profile. 5 *b*. Same seen in front.

Under this name I propose to describe a small trilobite from Topsail Head, which seems nearer to this genus than to any other, though it combines characters which recall several other genera. Some of the features are such as might be looked for in the young of species of Selenopleura, but the shield, on which the following description is founded, seems to have attained its permanent features. In the long, cylindrical glabella, somewhat wider in front than behind, and overhanging the anterior margin, it recalls the genus *Dolichometopus*, Ang., Linrs.; in its dorsal suture comparatively straight, and near the outer margin of the shield it approaches *Agraulos* and *Conocoryphe*. The general form, however, the granulated surface, projecting eyelobes, etc., seem to bring it nearer to *Selenopleura* than to any other genus.

Only the centre piece of the head shield is known. This is small, and of a trapezoidal, semicircular form; it is strongly elevated along the axis, and depressed at the sides and in front. The dorsal furrow is strongly impressed. The anterior margin is depressed, and is strongly arched backward near the suture, so as to narrow considerably the outer end of the anterior limb of the fixed cheek. There is a narrow, rounded fold to the anterior margin, and a distinct and moderately wide furrow behind it.

The glabella is cylindrical, somewhat wider in front than behind, narrowest between the first and second furrows, prominently elevated for most of its length, and has flattened slopes; it is depressed at both extremities, and is indented on the sides by three pairs of furrows, which are progressively longer from the posterior to the anterior; the former extends scarcely half-way to the axis of the glabella, but the latter, which is strongly directed forward, two-thirds; the glabellar furrows are broad and shallow. The occipital ring is rather narrow, and is sharply divided off from the glabella by a narrow, deep furrow; it is somewhat pointed behind, and bears an indistinct tubercle on the middle.

The fixed cheek, behind the ocular fillet, is subtriangular, moderately elevated toward the glabella, but depressed at the outer sides. The eyelobe is short, prominent and distinctly elevated; the ocular fillet is broad, but not conspicuous. The posterior margin is somewhat angulated upward in the middle, and is rounded forward at the outer angle: the marginal fold is narrow, and slopes forward to the furrow; the furrow widens and turns forward as it goes toward the genal angle.

The whole surface is covered with minute granulations, which are coarser and more conspicuous on the elevated parts of the shield than elsewhere: on the higher part of the glabella these granulations pass into imperfect ridgelets, which are concentric to the elevated portion of the glabella where they are most conspicuous; they are most distinct on the posterior third of the glabella. The backward flexure of the anterior margin of the centre piece of the head-shield indicates that this species had a narrow free cheek.

Length of the cephalic shield, 3 millimetres; width of the centre piece, 5 mm.; height, 2 mm.

Locality.—Topsail Head, Conception Bay, Newfoundland.

This species may be distinguished from *Selenopleura parva*, Linrs., by its more gibbous form, long glabella, and distinct glabellar furrows and ocular fillet; from *S. cristata*, Lins., by its long, overhanging glabella and the narrow anterior limb of the shield; from *S.? stenometopa*, Ang., by its narrow, unangulated anterior margin; from *S. holometopa*, Ang., by the short and narrow anterior margin, and more advanced position of the eyelobe; from *S. comm unis*, Bill., and *S. Acadica*, Whiteaves, by the same feature and the longer glabella.

XII.—*Notes on the Limestones of East River, Pictou, N.S.*

By EDWIN GILPIN, JUN., A.M., F.G.S.

(Read May 27, 1886.)

The following analyses of limestones, from the Lower Carboniferous Marine Limestone series of Pictou County were made some years ago by the writer, when engaged in an investigation into the subject of fluxes for the extensive deposits of iron ore which characterize this district, and they may be appropriately prefaced by a few remarks on the extent and distribution of the Lower Carboniferous measures of East River.

The general arrangement of the subdivisions of the Carboniferous system in this county can be readily recognized, and is given in sufficient detail in Sir W. Dawson's "Acadian Geology." It may be remarked that, in the district more particularly referred to in these notes, viz., that extending from Glengarry, on the Intercolonial Railway, to McLellan's Mountain, the Lower Coal formation does not appear, and may be represented on the eastern edge of the district by the conglomerate beds of Irish Mountain and McLellan's Brook.

On Big Brook, a tributary of West Branch, about four miles above Hopewell, are met limestones and gypsum with red shale and flaggy sandstones, resting on Siluro-Cambrian measures, and dipping to the north. These limestones are exposed on the West Branch and can be traced south of Grant's Lake to the valley of East River. They are associated with red shales, and red and gray sandstones, and the measures are broken through by several masses of the dioritic trap, probably contemporaneous. Exposures of gypsum are not met until near the mouth of Archibald's Brook. Here a compact, blue limestone, about thirty feet thick, is overlaid by marl, and by an immense mass of gypsum, about 100 feet in thickness.

It is impure in quality, and contains layers of marl and siliceous matter. In the upper part, are layers of granular and fibrous, red gipsum. Above this come beds of hard, red, shale, having a general dip to the west. The course of the gypsum, as marked by funnel-shaped pits, is southerly or parallel to that of the river. Its final exposure in this direction is distant about three miles, at the Black Rock, where a small outcrop is visible on the east bank of the river, on the farm of Mr. J. McDonald. At this point, it is associated with a pyritous, greenish, compact marble, and a compact, blue limestone, carrying limonite, and the section rests on a great mass of an indurated breccia, connected with the Cambro-Silurian measures of the opposite bank of the river.

Underlying the strike of the gypsum, on the west side of the river, are frequent exposures of hard, shaly, red sandstone, of soft marl, and of red and green argillaceous shales, interrupted at several points by dykes of black and dark-green dioritic trap. These measures rest on the Cambro-Silurian slates, carrying specular and limonite iron ores, and

near the line of contact, at a point opposite the Black Rock, are met limestones carrying limonite. The bed of the river, and the narrow valley from this point for some distance south of Sunny Brae, are occupied by limestone beds (No. 1),[1] the principal exposures of which show a hard, compact rock, of grey and bluish colors, in places arenaceous or marly. Returning along the east bank of the river, on C. MacDonald's farm, is a compact, bluish limestone, holding rounded pebbles of the slaty breccia.

Still further north, at Bridgeville, opposite the large exposure of gypsum, already alluded to, trial pits showed limonite, filling the junction between Upper Silurian shales, and limestone and gypsum. In all probability this gypsum is connected with that exposed on the opposite bank of the river. Between this point and Springville, limonite and limestone mark the contact of the two systems. In the bank of the river, at McPhee's, is met a large bed of dark-blue, compact limestone (No. 2), weathering to an ochre, and holding nodules of hard, blackish, arenaceous limestone. The thickness of this bed is about 90 feet. At the point where the section is visible, the limestone folds over a spur of the Silurian slates, and its lower part holds fragments of it. The limestone strikes to the north-east, along the side of the hill, and is exposed again in the Cross Valley Brook in an interesting section. The gray and brown Upper Silurian slates, stained with patches of peroxide of iron, and filled with seams holding red and white quartz and calcspar, strike S. 75° E., and dip heavily to the north. Resting on them is a breccia of fragments of the slates. On the side next the older rock, the calcareous cement can hardly be distinguished, but at a distance of six inches, the slate fragments grow scattered and are united by dark-grey limestone, which quickly predominates to the exclusion of the slate. The limestone (No. 3), as exposed, is about fifty feet thick, but its normal dimensions are much greater.

Immediately overlying the limestone is a wide outcrop of gypsum and marl, imperfectly exposed, and extending to the road from Springville to New Glasgow. The line of junction then turns to the north, and passes over Irish Mountain, at the north end of which it is marked by conglomerates. The gypsum may be traced by surface pits, on the same course, but it is not exposed until A. Cameron's farm, south of Forbes Lake, is reached. Here it forms a large outcrop, resting on soft, grey marl and shale. The lower beds of the gypsum are laminated and impure in quality. In the middle of the deposit which appears to be about 60 feet in thickness, is a bed twelve feet thick, white and of good quality. A few tons are quarried annually and "boiled" for local use. The overlying beds are coarser, in quality, with layers of soft, white gypsum. Above the gypsum and marls are exposures of red and gray shales with limestones, giving in all a section of about 450 feet. The beds dip a little to the west of north, with an inclination which is heavy near the older rocks, but gradually diminishes toward the upper part of the section.

Returning toward Springville, at L. McLean's are met several thick beds of limestone (No. 4) dipping to the west of north, and overlying the gypsum, probably about 200 feet, the interval being occupied by red shales and marls. At the East River Bridge, near Springville, about on the line of McLean's limestone beds, are numerous exposures of compact, gray and blue limestone, sometimes argillaceous, succeeded by red and gray sandstones, with soft argillaceous shales and marls.

[1] The numbers given in the text correspond to those of the analyses, and to those marked on the sketch map.

The general relations of these strata may be gathered from the following section, from a survey of the East River, below Springville, made by me some years ago :—

	Feet.	In.
Black, bituminous, arenaceous shale	13	0
Black, bituminous limestone	24	6
Hard-blue limestone, with arenaceous bands	3	2
Very hard, compact, blue limestone	5	2
Soft, laminated, calcareous shale	2	3
Blue limestone	1	0
Soft, laminated, drab shale	0	4
Blue, argillaceons limestone	0	4
Calcareous, argillaceous shale, joints filled with calcspar and fluorspar	2	0
Gray, argillaceous limestone, in places passing into shale	2	0
Hard, blue limestone	2	10
Compact, white, calcareous sandstone	0	2
Shaly, drab marl, holding sandstone concretions, and veins of calcspar	13	9
Gray, compact limestone	0	6
Bluish-gray compact limestone	1	2
Drab, arenaceous shale	0	9
Soft, grey argillaceous limestone	1	4
Hard, blue, impure limestone	1	9
Gray, concretionary, argillaceous shale, with bands of arenaceous shale	10	0
Soft, gray limestone	0	11
Gray sandstone, calcareous	1	3
Bluish, arenaceous limestone	5	4
Hard, blue limestone	4	5
Gray, impure arenaceous and argillaceous limestone	5	9
Hard, blue, arenaceous limestone	1	4
Soft, drab shale	4	0
Impure, argillaceous limestone	2	4
Soft, red sandstone	1	6
Measures obscured (soft shale ?)	25	0
Rough, compact, blue limestone	3	10
Soft, grey, concretionary sandstone	2	6
Coarse, blue, argillaceous limestone	3	9
Measures concealed	39	0
Limestone	.....	
Total	186	11

Other sections show alternations of red and gray compact sandstones and red arenaceous shales, to the exclusion of limestones and marls, and, generally speaking, the limestones are not connected with extensive sections of sandstones.

About three-quarters of a mile below the Springville Bridge, is an exposure of limestone (No. 5) quarried for building purposes. Here there are several thick beds of argillaceous and calcareous shales, gray and breaking into thin splinters, and enclosing beds of pale blue or gray argillaceous limestone. These beds are very hard and compact and, owing to the presence of thin layers of calcareous fireclay or shale, split readily into blocks six to twelve inches thick. Similar limestones of a darker blue color, occur on the West Branch, and have been used successfully for construction purposes.

The measures referred to above are exposed in varying sequence in the river banks, as far as the forks, and preserve a general dip to the north and north-west, with frequent

faults and undulations. The Grant limestones (No. 6.) are apparently, about the middle of this formation, and may be paralleled with the Forbes, McLellan and Robertson limestones (7, 8, 9).

On the West Branch, a short distance above the forks, is a limited exposure of gypsum, which is associated with gray arenaceous limestone, and a series of thick bedded sandstones, holding Calcopyrite casts of plant remains. Similar limestones are met on the extension of the strike of these measures to the East Branch, and a bed of limestone (No. 10) several feet thick, composed of minute fragments of fossils, which give a rough pumice-like surface on weathering. This is, probably, the limestone referred to in "Acadian Geology" (p. 318), as showing in slices under the microscope, that it is made up of small fragments of shells, with entire specimens of very minute species.

Some of the limestones are well defined and persistent. At other points they are quite local. It sometimes appears as if there had been a local accumulation of calcareous matter (of shells or of a coral growth) which rapidly thinned from a central point, until lost in argillaceous or arenaceous matter.

The gypsum at the Forks may be considered as marking an horizon very near the summit of the Marine Limestone formation. It is difficult to arrive at any exact estimate of the total thickness of this formation in the district under consideration, starting from the basal limestone of McPhee's, and ending at the Forks. The longest continuous section that I have been able to measure, did not exceed 1,040 feet, but from all available data, the total thickness may be estimated at about 2,750 feet.

Below the forks of the river, measures referred by the officers of the Geological Survey to the Millstone Grit, are met as far as the base of the Productive Coal Formation, a short distance north of McKay's Brook, As yet, no fixed line can be drawn dividing these subdivisions. These millstone grit measures, it may be remarked, are distinguished from the corresponding horizon in other parts of the province by their highly calcaceous nature—there being numerous beds of limestone, not usually equal in purity to those already noted, and the cementing material of the sandstones being often calcareous.

The Marine Limestones and their associated strata, become obscured as they approach the south side of the Coal Field on the east side of the East River, probably by east and west faults of great magnitude, similar to those which have on all sides limited the productive Coal Measures by an unconformable frame of Millstone Grit. Approaching Sutherland's River, they reappear and are noted for holding important deposits of spathic ore.

In this district I am not aware of any exposures of the peculiar "shell" limestone of Windsor, Shubenacadie, and Brookfield, referred by Sir J. W. Dawson, to Subdivision E of the Marine Limestone series, and parallelled by him with limestones belonging to the upper part of this section. This limestone is a mass of shells, principally casts, the delicate spirals of Spirifer and Athyris being frequently preserved intact. This characteristic limestone is largely quarried at Brookfield, as a flux for the Londonderry furnaces, and I am indebted to Mr. J. Sutcliffe, of the Londonderry mines, for the analysis of it, given further on, placed for comparison with one of the same rock from Windsor.

The analyses which I submit of East River limestones, were made by me sometime ago, when engaged in an enquiry into the question of fluxes for the extensive iron ore deposits of the district, some of which have been incidentally alluded to in my remarks.

They are of samples selected principally from beds considered important from their extent or convenience to transportation facilities. Their value is merely that of their being the first attempt at representing the composition of this mineral over a considerable tract of ground in Nova Scotia; and the point which is brought out, is of their comparatively non-magnesian character, except in the case of some of the lowest beds. They are arranged in ascending order, and their numbers correspond with those marked on the accompanying sketch map:—

(1.) Sunny Brae Limestone.—Color bluish, with seams of white and brownish calcspar, and occasional coarse grains of siliceous matter. Some parts of the deposit show obscure fossil marks.

Moisture	·056
Lime Carbonate	85·767
Magnesia Carbonate	3·155
Iron carbonate	1·167
Iron Sulphide	·905
Phosphoric Acid	·376
Insoluble	8·440
Total	99·866

(2.) McPhee's Limestone.—*Sample A.*—Smooth, compact, bluish gray with crystals of silica, and no visible fossils, weathers yellow.

Sample B.—From overlying bed of same exposure. Hard, black, laminated limestone, giving drab powder, and bituminous smell, fossiliferous.

Composition.	Sample A.	Sample B.
Moisture	.....	2·356?
Lime carbonate	84·220	58·112
Magnesia carbonate	11·250	6·571
Iron peroxide	·282	1·850
Manganese peroxide	1·100	.....
Sulphur	·031	·025
Phosphoric acid	trace	·351
Alumnia	·617	.....
Insoluble residue	2·650	30·760
Carbonaceous matter	.....	small
Total	100·150	100·025

(3.) Cross Brook Limestone.—*Sample A.*—From limestone near point of junction, compact, brittle, drab-colored limestone, with calcspar crystals, no visible pyrites or fossil markings.

Sample B.—From overlying part of same bed. White and gray, not very compact, crystalline limestone, weathering red, with a few crystals of galena and iron pyrites, and obscure fossil markings.

Composition.	Sample A.	Sample B.
Moisture	1·250	·115
Lime carbonate	91·500	58·766
Magnesia carbonate	·465	9·890
Iron carbonate	2·278	26·812
Manganese	trace	1·255
Alumina	·510	.....
Iron pyrites	·737	·168
Phosphoric acid	·198	.....
Insoluble residue	1·856	3·082
Total	98·794	100·088

(4.) McLean Limestone.—Compact gray limestone, with abundant fossil coral markings.

Composition.	Sample A.	Sample B.
Moisture	·18	·17
Lime carbonate	93·90	96·26
Magnesia carbonate	2·45	2·33
Iron peroxide	·59	·57
Manganese peroxide	·56	.55
Alumina	·12	·10
Sulphur	·03	.02
Phosphoric acid	·03	.03
Silica	2·10	1.99
Total	99·96	102·02

Analyst, Durham College of Science.

(5.) QUARRY LIMESTONE.—Flaggy, argillaceous limestone, drab colour, with few crystals of iron pyrites, and abundant fossils.

Moisture	·56
Lime carbonate	43·12
Magnesia carbonate	2·56
Iron carbonate	4·10
Manganese peroxide	2·55
Sulphur	....
Phosphoric acid	....
Insoluble residue, silicate of alumina, and a little sand	47·00
TOTAL	99·89

(6.) GRANT LIMESTONE.—Compact, grayish-blue, rough, red-weathering limestone, with veinlets of white iron and calcspar, and a few crystals of iron pyrites; abundant, obscure, fossil markings.

Moisture	1.110
Lime carbonate	90·660
Magnesia carbonate	2·360
Iron carbonate	2·280
Manganese	.....
Alumina	.515
Iron sulphide	·600
Phosphoric acid	·125
Insoluble residue	2·090
TOTAL	99·740

(7.) FORBES LIMESTONE.—Dark, earthy blue, rough limestone, with veinlets of white and brown ferruginous spar, and crystals of dogtooth spar, and grains of siliceous matter; no visible fossils.

Moisture	·124
Lime carbonate	89·600
Magnesia carbonate	1·560
Iron peroxide, Manganese peroxide	·589
Iron carbonate	1·550
Iron sulphide	·225
Phosphoric acid	·055
Insoluble residue	5·743
TOTAL	99·446

(8.) MCLELLAN LIMESTONE.—Compact, dark blue limestone, with numerous broken fossils; little visible pyrites.

Moisture	——
Lime carbonate	87·437
Magnesia carbonate	1·417
Manganese peroxide	·301
Iron peroxide	2·330
Iron sulphide	2·159
Phosphoric acid	trace.
Carbonaceous matter	·110
Insoluble residue	4·120
TOTAL	97·874

(9.) Robertson Limestone.—Dark, earthy blue, compact, argillaceous limestone, with numerous fossils and a few small crystals of silica and iron pyrites.

Moisture	1·156
Lime carbonate	78·344
Magnesia carbonate	trace.
Iron carbonate	2·224
Manganese carbonate	4·245
Iron sulphide	·482
Phosphoric acid	·064
Insoluble residue	11·600
Total	98·115

(10.) Forks Limestone.—Compact, bluish-black limestone, with crystals of calcspar and spots of arenaceous matter.

Moisture	·330
Lime carbonate	79·130
Magnesia carbonate	2·185
Iron carbonate	5·619
Manganese oxide	trace.
Alumina	·495
Iron sulphide	·754
Phosphoric acid	·403
Insoluble residue	11·392
Total	100·308

(11.) Shell Limestone.—The following are analyses of the "shell" limestone from Brookfield and Windsor, referred to in these notes:—

Composition.	Brookfield.		Windsor.
	I.	II.	
Lime carbonate	97·39	98·844	97·64
Magnesia carbonate	·94	·396	1·10
Oxide of iron	2·70*	2·000*	·07
Phosphoric acid	——	——	trace.
Insoluble residue	trace.	trace.	·68
Total	101·03	101·240	99.49

* Containing alumina.

These limestones, which can be compared most aptly to a heap of recently opened and cleaned shells thrown together, are notable for their freedom from phosphorus, sulphur, etc., and are apparently little beyond pure carbonate of lime, the iron oxide and alumina being carried in mechanically by water from the overlying clays.

XIII.—*Preliminary Report on some Graptolites from the Lower Palæozoic Rocks on the South Side of the St. Lawrence from Cape Rosier to Tartigo River, from the North Shore of the Island of Orleans, one mile above Cap Rouge, and from the Cove Fields, Quebec.* *By* PROF. CHAS. LAPWORTH, LL.D., F.G.S.

(Communicated by J. F. Whiteaves, and read May 27, 1886).

The collection of Graptolites from Gaspé, Gros Maule, Orleans Island and Cove Fields, etc., made by various members of the staff of the Geological Survey of Canada, and forwarded to me at the request of Dr. Selwyn,[1] has been examined by myself, and the majority of the species identified. Several of the forms, however, require further study. Some are new to science; while others present characteristics which render their identification with described types a matter of very grave doubt. These dubious forms must stand over until I have a little more leisure; but I do not believe that the additional facts they may afford, after further study, will greatly affect the main points laid down in this preliminary report.

I find that the Graptolites forwarded in this collection belong to several very distinct zones, each of which corresponds very closely with a distinct Graptolite zone in Great Britain and western Europe; so that, while (as all American geologists are aware) the equivalency of these Graptolitic beds of the St. Lawrence with the calcareous strata of New York and western Canada is as yet incapable of exact settlement, the relative geological antiquity of the recognizable zones can be fixed, with a close approximation to certainty, by comparison with their European representatives. The zones represented in this collection range from the British Tremadoc Slates to the middle of the Bala or Caradoc Formation of Wales and the West of England. But while some of the European zones within this stratigraphical range are fully represented in the collection, the fossils of others are strangely missing, even of some zones already known as certainly existing within the limits of the ground covered by the collection.

The several species I have already identified either with certainty or provisionally, together with their localities, as shewn by the specimens in the collection, are given in the appended table. (See *Table B.*) Those to which an asterisk is prefixed will need further examination. The fossil-bearing localities are arranged generally in order of geological age in the table, simply as a matter of convenience in reference. The same rule will be observed with respect to the recognizable Graptolitic zones in the order of description.

[1] The specimens from the south shore of the St. Lawrence below Quebec and from the Island of Orleans were collected in 1878, those from the Cove Fields, Quebec, in 1884, and those from near St. John's market at Quebec, in 1885, by Mr. T. C. Weston. The species from one mile above Cap Rouge, were collected by E. Billings many years ago (prior to 1862), and the fragments of a Dictyonema, from Cape Breton, by Mr. Hugh Fletcher, in 1876. The whole have been recently submitted to Prof. Lapworth, at the request of Dr. Selwyn.—J. F. W.

ZONE I.—*Cape Rosier Zone: Zone of* DICTYONEMA SOCIALE *and* BRYOGRAPTUS.

The oldest Graptolitic zone represented (as will be seen from the accompanying tables) is the *Dictyonema sociale* zone of Barrasois River (Cape Breton Island) and of Cape Rosier, Gaspé. There are very few specific forms occurring in this zone, but they constitute together a very peculiar and distinct group, totally different from those of the remaining zones. The genera include *Dictyonema*, *Bryograptus* and *Clonograptus*, together with the dubious genus *Staurograptus* of Emmons. The Dictyonema appears to me to be absolutely identical with one of the forms referred by European (Scandinavian) geologists to *Dictyonema flabelliforme*, Eichwald, which is also, so far as our present evidences enable us to judge, identical with *Dictyonema sociale*, Salter, from the Tremadoc of North Wales.

To this zone belong the Barrasois River beds, those of Cape Rosier, of Little White River, of Grand Méchin Point, of half a mile west of Long Point, Matane, Little Capucin River, etc.

In Europe, this zone (or zones) occurs in the Tremadoc of Wales and the Tremadoc and Ceratopyge beds of Norway (Brögger) and Sweden (Tullberg). It is Upper Cambrian (as British geologists receive the term), and is probably represented in the west by a part of the Calciferous series of New York and western Canada. It is distinctly older than the Graptolitic mass of the Point Levis beds. Not one of its forms has hitherto been figured from the Quebec group. It may occur at Point Levis, if the Calciferous is represented there. This is a point for future discovery to settle. In the meantime, however, it will be better to refer to the zone as the "Cape Rosier Zone." Like the Levis Calciferous Conglomerate beds, its fauna is made up of genera, partly Cambrian and partly Ordovician (i. e. partly Primordial and partly Cambro-Silurian.)

The Cambrian age of the Dictyonema-bearing Barrasois River beds of Cape Breton Island is demonstrated by their included Olenidæ. The Dictyonema beds of Gaspé and Méchin cannot be far above this Cape Breton zone. It is exceedingly probable, therefore, that, as in Cape Breton, the Dictyonema beds lie not far removed from the unconformable base of the fossil-bearing rocks of the district. If so, then the Shickshock metamorphic rocks would come exactly into the place of the Cape Breton "Pre-Cambrian," while the Acadian, St. John, or Paradoxides-bearing beds of the Lower Cambrian would be missing from Gaspé to Quebec, along the south of the St. Lawrence, as they are along the north of the St. Lawrence, from Quebec to Lake Superior.

ZONE II.—*Ste. Anne Zone: Zone of* PHYLLOGRAPTUS ANNA; *Graptolites from Rocks three miles above Ste Anne.*

This is clearly the second zone in order of geological antiquity. It is newer than the Cape Rosier beds by a well-marked interval, and much older than the Marsouin River zone, next to be described. None of its species are common to the other zones, so far as known, nor are they known in European equivalents of these zones. The only specimens from this special zone in the present collection are from Ste. Anne des Monts (three miles above.) The species fairly identifiable include:—

Tetragraptus bryonides, *Hall.*	Phyllograptus Anna, *Hall.*
" fruticosus, *Hall.*	Didymograptus extensus, *Hall.*

These are all well-known Point Levis species, according to the classical monograph of Prof. Hall, and they also occur together upon the corresponding Arenig-Skiddaw horizon in Europe, in the Shelve Arenigs, in the Skiddaw Slates, and in the Phyllograptus beds of Norway and Sweden.

If, as I believe, there are several zones in the Point Levis beds, this zone is probably about the middle of the series as there represented. Some of the Point Levis forms figured by Hall are apparently older and a few newer; that is to say, if we may rely upon the European evidences at our command.

It is somewhat remarkable that there is no other trace whatever of this Ste. Anne Phyllograptus zone in the present collection, among the fossils from the east of River Ste. Anne. The lithological characters of these Phyllograptus-bearing strata are, according to my experience of Graptolitic rocks, those of a zone likely to be persistent for great distances.

It would be interesting to know whether the form of this zone are met with associated with the Phyllograptus said to occur in the shales among the sandy rocks near Cape Chatte (Geol. Rep., 1880-1-2, p. 26 DD.) On one point we may, I think, assure ourselves, with our present knowledge of the Graptolites of Europe, viz., that the Phyllograptus beds of Ste. Anne are newer than the Bryograptus beds of Cape Rosier, and older than all the other zones in this collection. This zone answers precisely to the typical Arenig (Phyllograptus) beds of Wales, Skiddaw, Norway and Sweden, as well as to the typical zones of Phyllograptus, etc., at Point Levis.

This Phyllograptic zone ought to be sought for among the green and purple rocks between Cape Rosier and Griffin Cove, and among the sandy and conglomeratic rocks along the coast where the Pillar Sandstones come out in force far to the east of the Ste. Anne. The Dictyonema bed again should be sought for at Point Levis and elsewhere, and its relation to the so-called "limestone conglomerates" demonstrated. The line between the Cambrian and Ordovician (Cambro-Silurian) must, in time, be drawn very near this zone of Dictyonema and Bryograptus.

ZONE III.—*Griffin Point or Marsouin River Zone: Zone of* CŒNOGRAPTUS GRACILIS.

This zone is by far the most fully represented in the collection. The chief localities which have yielded its fossils are:—Marsouin River (a little above), one mile east of Griffin Cove, one mile above Tartigo River, north-west point of Griffin Cove, half a mile below Little Méchin River, near Fox River; one mile above Cap Rouge, near Quebec, and the Little Falls, Magdalene River.

In all these localities the fossils are essentially the same, the same species recurring again and again, in some cases in about the same relative proportion. It will be seen from the table, that the list of fossils is more complete from some localities than from others. It may be that it will be possible, in time, to subdivide this zone, which has probably quite as great a vertical extent in Canada as it appears to have in England, but as yet it is decidedly safest to refer all the rocks named above to this single zone.

The most characteristic forms from the zone are :—

Didymograptus sagittarius, (*Hall* non *Hisinger.*)
Cœnograptus gracilis, *Hall.*
Dicellograptus sextans, *Hall.*
Lasiograptus mucronatus, *Hall.*
Climacograptus antiquus, *Lapworth.*
Diplograptus Whitfieldi, *Hall.*

So far as known, these are peculiar to this zone, and the presence of a single one of these species is sufficient to settle the age of the rock in Great Britain, and in all likelihood in America. With these peculiar forms, however, are associated others, which have a much longer vertical range, and unite this zone to the one which follows it in order of time. These species of long range are :—

Dicranograptus ramosus, *Hall.*
Glossograptus ciliatus, *Emmons.*
Diplograptus putillus, *Hall.*
Climacograptus Scharenbergi, *Lapworth.*

They all pass up into the British zone next above the Cœnograptus zone, together with the following species, which range up through at least three complete zones :—

Diplograptus foliaceus, *Murchison.*
Climacograptus bicornis, *Hall.*

This special Marsouin zone, now under consideration, has long been recognized by geologists upon the continent of America. Its fossils were described many years ago by Professor J. Hall, in his "Palæontology of New York," from the dark shales of Norman's Kill, near Albany, in the valley of the Hudson River. Hall also referred to the detection of the Norman's Kill fossils on Marsouin River by Sir William Logan and the Canadian Survey; but the discovery of the existence of rocks containing the Norman's Kill fossils as far down as Griffin Cove and between the Marsouin and Quebec, as demonstrated by the present collection, is wholly due to those officers of the Geological Survey of Canada, who have studied the district since the retirement of Sir W. Logan. There can be no question of the general identity of this Griffin Cove rock and the Marsouin Cœnograptus zone with that of the Norman's Kill of the Hudson River valley. The New York geologists have always adhered to the opinion that the Norman's Kill beds are of the age of the Hudson River group (Lorraine) or of that of the Utica Slate. The best advocacy for the last named view will be found in a letter from Mr. R. P. Whitfield, addressed to Dr. White, and published in the Report of the Geological Survey of the 100th meridian (Vol. IV. p. 101); in which it is asserted that *G. serratulus*, Hall, *D. pristis*, *C. bicornis* and *D. ramosus* occur in the Utica Slate of the valley of the Mohawk. I have myself referred to the Norman's Kill beds in my paper on the Moffat Series (Quaterly Journal of the Geological Society, 1878, p. 335) as probably rising out unconformably from below the Trenton Limestone, and forming the highest portion of the convoluted rocks of the so-called Quebec Group,—a view also held by Dr. Sterry Hunt. At a later date (see "Distribution of Rhabdophora," 1880, pp. 30, 28, etc.), while I refused to allow their equivalency with the Lorraine Shale (Hudson River Group), I reluctantly admitted that it was very probable

they might in part be Utica and in part of true Trenton age. But here we have to recollect that with the exception of Whitfield's distinct assertion that *G. serratulus*, Hall, occurs in the Utica Slate of Oxtungo Creek—which may be easily accounted for on the supposition that what Whitfield calls a *Didymograptus* may possibly be a *Leptograptus*—not a shadow of palæontological evidence has yet been adduced to shew that these Norman's Kill or Marsouin rocks are newer than the Trenton.

I will not discuss the evidences further in this place, but will merely say that in Great Britain the fossils of the Cœnograptus (Norman's Kill) zones occur in the beds immediately succeeding the typical Llandeilo Limestone of Wales, with *Ogygia Buchii* and *Asaphus tyrannus*, and in association with the Craighead (Stinchar) Limestone of Scotland, with *Maclurea Logani* and *Ophileta compacta*, i.e. in beds apparently homotaxeous with the Chazy or Lowest Trenton (Bird's Eye and Black River).

If, therefore, we provisionally regard this Norman's Kill (Marsouin and Griffin Cove) zone as coming between the Chazy (Maclurea) and the Trenton Limestone in America, it will answer roughly to its equivalent, the *Coenograptus gracilis* Zone in Great Britain, in age as well as in fossils. It may even lie in some localities conformably at the summit of the Quebec series of the Eastern Townships, and then, as suggested above, come out unconformably below the New York Trenton along the line of the St. Lawrence and Hudson Rivers; while, where there is no unconformity, it may shade off into the Chazy below and the Trenton Group above, as possibly in the Bird's Eye and Black River localities in eastern Canada. The Chazy is usually associated by Canadian authorities with the Calciferous below—the great break supposed to be between the latter and the Black River. The fossils of these Norman's Kill rocks should be sought for in the top of the Chazy and bottom of the Trenton, as well as in the Utica; the discovery of a few characteristic forms would soon settle the difficulty.

There is not a doubt that these Cœnograptus or Norman's Kill (Cap Rouge, etc.) beds belong to the second fauna of the Ordovician (Cambro-Silurian), i.e. they are newer than the Graptolitic strata of the Point Levis beds of the Quebec group; in other words, they belong to the Trenton-Utica fauna and not to the Calciferous-Chazy fauna. But, while this is true, we must remember that they appertain, possibly, almost to the very lowest beds of that second fauna, i.e. their place is practically Trenton-Utica, and not Utica-Hudson.

I should expect, therefore, that while the calcareous rocks associated with this Marsouin fauna hold many Trenton forms, yet there might occur, associated with them, survivors of the Chazy type, and perhaps a number of Black River forms.

As a first contribution towards a solution of the difficulty, I shall be glad to know if it is possible yet to answer the following questions by evidence at the command of the Canadian Geological Survey:—

(*a*) What are the trilobita and brachiopoda of the Calciferous beds of Griffin Cove, and from Griffin Cove to Gros Maule?

(*b*) Have any Graptolites been afforded either by the Black River or Trenton of the north of the St. Lawrence, and, if so, what are they?

(*c*) Has a single example of one of the peculiar species (see list before) of the Marsouin beds been detected in any Utica or Hudson River bed on the north and west sides of the St. Lawrence, from Lake St. John to St. Mary's Strait, and, if so, what, and where?

A detailed reply to each of these questions would be of especial service at this stage of our enquiry. At present, the evidence is not fully complete. In our British Ordovician rocks, the Cœnograptus (Norman's Kill) zone is about half way up the total succession, i.e. in the middle of the Llandeilo formation, which has the Arenig below, and the Caradoc above. On a priori grounds, this also must be its place in the Canadian succession. The difficulty lies in finding the true base of the Ordovician in Canada. If the Chazy answers broadly to our Arenig, the Trenton to our Llandeilo, and the Utica and Hudson River Group to our Caradoc, then the place of this Cœnograptus zone is in the middle of the Trenton. If the Chazy overlies the Quebec Group, then the Cœnograptus zone lies below the Trenton. If the Trenton is of the age of our Middle Llandeilo, then the Cœnograptus zone answers to the lowest Utica beds; but this, as I have here said, I hold to be not yet demonstrated. In any case, the place of the Cœnograptus zone is about midway between the base of the Point Levis (Phyllograptus beds) and the summit of the Lorraine (Hudson River Group.)

Subzone III A.—*Rocks of the Cove Fields and St. John's Market, Quebec, and of the North Side of the Island of Orleans.*

The fossils from these localities are few in number, and somewhat difficult of identification. The species are all of Llandeilo-Bala age (see Comparative Table), and the general facies indicates an horizon about the summit of the Cœnograptus or Marsouin beds zone, last described. The association of forms reminds me of that of the highest Glenkiln and lowest Hartfell beds of the south of Scotland. I should imagine that they follow on at once upon the Cœnograptus beds without a break—indeed, it is possible that Cœnograptus may be detected among them; but, judging from the British phenomena, this is doubtful. It is not unlikely that these Cove Field beds mark the transition from the Marsouin beds into the lowest zones of the Black River or Trenton Limestones. The presence of a form identical with, or closely allied to, the *G. amplexicaulis* of Hall, points in this direction.

The main point is perfectly clear. There is nothing in the Cove Fields and St. John's Market fauna that reminds us, in the slightest degree, of the fauna of Point Levis. The fossils are the fossils of the Marsouin River fauna, or second Ordovician fauna, and have not a species in common with the first Ordovician fauna—the typical fauna of the rocks of Point Levis.

Summary.

(1.)—The Graptolites of the collection examined are all derived from rocks of greater antiquity than the so-called Utica and Hudson River rocks, if we regard these as typified by the fauna hitherto described from the Graptolitic rocks of Lake St. John, Canada, and those of the valley of the Mohawk, in the State of New York.

(2.)—There are two grand faunas represented in the collection:—(A) The so-called Quebec fauna of the Calciferous-Chazy formations of Cape Breton, Cape Rosier, Point Levis and Ste. Anne, which answers to the fauna of the British Upper Tremadoc and Arenig rocks and their European equivalents; and (B) the Griffin Cove, Marsouin River

and Norman's Kill fauna, which answers to the fauna of the middle zones of the European Ordovician or Cambro-Silurian rocks.

(3.)—In each of these grand faunas are found two subfaunas, those of the lower faunas being the more distinctly separable:—

A.—Quebec or Calciferous-Chazy Fauna.

Subfauna 1.—*Cape Rosier and Barrasois River Zone*, of Calciferous age=Tremadoc Rocks of Great Britain and Ceratopyge and Dictyonema Beds of Norway.

Subfauna 2.—*Ste. Anne River Zone*, of Point Levis age=typical Arenig of Great Britain; Phyllograptus Beds of Scandinavia, etc.

B.—Trentonian, Marsouin River, or Norman's Kill Fauna.

Subfauna A.—*The Coenograptus Zone of Griffin Cove and the Marsouin River* answering to the Middle Llandeilo Beds of Great Britain, to the Glenkiln Beds of Scotland, etc.

Subfauna B.—*The Cove Fields and Orleans subfauna;* apparently destitute of *Cœnograptus gracilis*, and answering to the highest Llandeilo or Lowest Caradoc Beds of England.

(4.)—The last of these subfaunas shews evidence of a transition into the Utica-Lorraine Graptolitic fauna of the Mohawk valley, New York, and of Lake St. John, Canada.

(5.)—From a comparison of the foregoing facts, it follows that:—

First.—If the strata associated with the Pillar Sandstones near Cape Chatte and elsewhere actually contain Phyllograptus (see Report Geological Survey Canada 1880-1-2, p. 26 DD.) then, as these strata always appear to come between the Levis conglomerates and the Marsouin rocks, there may be no necessity for presuming any general fault or overlap between the so-called Levis beds of the Gaspé-Marsouin area and the more recent so-called Utica beds of the same district. There may be, on the other hand, in some localities an uninterrupted succession from the base of the Cape Rosier rocks into the very highest beds along the south shore of the St. Lawrence.

Secondly.—If there be no break in the great succession, then the sequence in the Gaspé peninsula must be simply regarded as generally inverted, faults and folds being probably present in abundance; but the succession from the St. Lawrence southward must be regarded as a generally descending one. On this supposition, if we may judge from the local sequence of the rocks and fossils as laid down in Mr. Ells's "Report on the Geology of the Gaspé Peninsula" (Report of Progress 1880-1-2, DD viii.) the ascending succession may perhaps be somewhat as follows:—

Possible Ascending Succession of Strata, on the South Side of the St. Lawrence, from Cape Gaspé to Tartigo River.

PRE-CAMBRIAN.

(A).—Metamorphic Rocks of the Shickshock Ranges.

CAMBRIAN.

(B.)—Cambrian Formations.

B.[1]—Fine conglomerates, with white quartz pebbles; red, brown, grey and black slates. (Localities: Grande Carrière, etc., and flanks of the Shickshock Range).

B.[2]—Grey, red, brown and black shales, with beds and bands of dolomite. (Localities: Les Islets, coast south of Cape Rosier, etc.) Fossils: *Dictyonema, Bryograptus*, etc.

[B[1] and B[2] may, perhaps, represent both the Upper Potsdam and the Calciferous rocks of the western district of New York and central and Upper Canada.]

ORDOVICIAN.

(C.)—Ordovician or Cambro-Silurian Formations.

(1.) *Lower Division or Quebec Group of Logan.*

C[1]—Hard grey quartzite, quartzose sandstone, limestone, conglomerates, etc, with seams of black shale (Ste. Anne, Cape Rosier, Tartigo River, etc., with Levis Trilobites) and grey shales with seams of dolomitic rocks. Fossils: *Phyllograptus, Tetragraptus, Didymograptus.*

C.[2]—Grey, green, purple and clouded shales, interstratified with grey and black slates, and passing into

C.[3]—Hard green and grey sandstones of great thickness, interstratified with red, green and grey shales. Localities: Ste. Anne des Monts, Cape Chatte, etc., etc. (Pillar Sandstones.)

The limestone conglomerates, etc., at base of C[1] may answer to the asserted break between the Calciferous and Chazy in New York and elsewhere; and the Pillar Sandstones may come into the place of the Chazy Sandstones of Grenville. In this event, the Quebec of this area would answer generally to the Chazy of the west; the Calciferous fossils of the conglomerates may be derived from fragments of Calciferous rocks. C[1], C[2] and C[3] would answer precisely to Logan's Levis, Lauzon, and Sillery divisions.

On the other hand as it appears by no means unlikely, from the fact that westward from the mouth of Marsouin River, the beds with *Dictyonema sociale* seem to lie always between the Pillar Sandstones and the local Levis conglomerates and shales, it is possible that these Pillar Sandstones are actually below the Dictyonema beds; and thus come broadly speaking, into the place of the Potsdam formation. If this be the case, then the zones C[3] of the foregoing sequence would answer to B[1], and C[2] to B[2]; the typical Levis strata C[1] would be the highest formation of the older series, yet recognized in the district. In this case also it follows of necessity, that the Griffin Cove and Marsouin River strata of the district under consideration must be separated from the so-called Levis strata by a gigantic fault or dislocation, as in the neighbourhood of Quebec.

(2.) *Middle Division, or Trenton Black River Rocks of Hall and Logan.*

C^4 (*a*). Hard, cherty, felspathic slates, with hard, grey sandstones.

C^5 (*b*). Black, bituminous shales and limestones, with beds of buff weathering dolomite beds, very fossiliferous; *Cœnograptus gracilis*, etc., etc. (Localities: Griffin Cove, Marsouin River, Gros Maule, etc.)

C^6 (*c*). Hard, grey sandstones, with knobbed surfaces (*D. pristis* abundant.) Localities: Cape Chatte, Cape Magdalene, etc. Fossils: *Leptæna sericea*, *Orthis testudinaria*, etc.

These beds can hardly be much newer than the Trenton Limestone of the eastern districts; such brachiopoda as occur in these rocks occur also in the Trenton, as well as the Utica and Lorraine. The sequences given above are merely suggested, and are deduced from the general geographical arrangement of the beds. They are valueless, except as starting points from which to commence a detailed study of the strata upon it.

(3.) *Upper Division, or Hudson River and Lorraine Rocks of Hall and Logan (apparently wanting.)*

Thirdly.—Thus it appears at present that we are destitute of any clear evidence that true Utica and Hudson River strata occur anywhere along the south side of the St. Lawrence, from Gaspé to Quebec; all the strata seeming to be older in point of time than the Utica proper, as typified by the rocks of Ottawa and Lake St. John. As to the two formations of the Trenton and Utica, being mapped in New York and western Canada essentially on lithological grounds, it is exceedingly probable that the line between them differs greatly in true geological age when followed from Quebec to Ottawa and New York; so that in some localities, where the Trenton Limestone series is poorly developed, the Utica of that locality actually descends to and includes the Norman's Kill and Marsouin zone. But this is a point for future investigation. The facts, as they stand, relate the Marsouin and Graptolitic shales to the Trenton rather than to the Utica Slate, as at present understood.

Fourthly.—The so-called Quebec rocks, of the town of Quebec, as typified by the fossils forwarded from the localities of the Cove Fields and St. John's Market, are not of Quebec age at all. They are probably the newest rocks represented in the collection, and possibly shade upwards from the Marsouin Graptolitic shales of Orleans Island and Cap Rouge. They appear, however, to be of greater antiquity than the Utica Slates of Lake St. John, answering to the basement zone of the British Bala, instead of to the middle zone, which seems to be the place of the Lake St. John shales.

Fifthly.—These conclusions enable us to afford fairly satisfactory replies to the questions propounded in your note:—Are the two distinct Graptolitic zones of the Gaspé area rightly entered upon the maps of the Survey as of Levis and Utica, and are they separated from each other by any stratigraphical break (unconformity or profound dislocation)? We see that Levis rocks are certainly present, but none that we can actually demonstrate to be of true Utica age, as we understand the term at present. The higher series of Graptolite-bearing rocks have, however, their exact equivalent in the Norman's Kill strata of the valley of the Hudson, referred by New York geologists to the Utica Slate, and they undoubtedly contain some well-known Utica forms. Hence these highest strata

were most properly referred to the period of the Utica formation, but it is imposssible to demonstrate the correctness of this reference in the present state of our knowledge. The zones represented range from the Calciferous to the Trenton-Utica, and their sequence appears identical with that of their representatives in Great Britain and northern Europe. But while we cannot yet actually prove the existence of any general unconformity or extraordinary dislocation, the normal sequence of the strata has been generally inverted, and appears to be locally interrupted by overturned folds and inverted faults.

Sixthly.—In western America, precisely as in some parts of the British Isles, the Lower Palæozoic rocks shew great variations in their lithological and petrographical characteristics in different geographical areas. In Great Britain (compare my papers on the Moffat Series and the Girvan Succession), this variation appears to be more or less related to the varying distance from the ancient Palæozoic shore-line—each formation graduating from a massive assemblage of coarse materials to a thin sheet of very fine silt, when followed in certain special directions. In the same way, the thick shore-derived mechanical deposits of much later formations have long been recognized as graduating into, and becoming represented by, their organically derived deposits (limestone and chalk, etc). I have for years held the opinion that the entire, more or less Calcareous series of the Lower Palæozoic rocks of New York State, and of the region west and north of the St. Lawrence, from the Potsdam below, to the Lorraine (Hudson River Group) above, was originally represented, formation above formation, in the vastly thicker, sandy, flaggy and shaly strata lying to the east and south of the great St. Lawrence and Hudson River Valley, from Gaspé to New York (i.e. in the strata to the east of "Logan's Line," generally lumped together by American geologists, as Quebec and Hudson River Groups). In the western Toronto-Ottawa calcareous formations, the usual Lower Palæozoic fossils (Brachiopoda, Crustacea, etc.) are present in abundance; the original sequence is undisturbed by folding or dislocation; and as a consequence, our knowledge of the chronological relationship of the various recognizable rock formations is fairly complete. In the eastern Quebec-Gaspé series, on the contrary, Brachiopoda and Crustacea are almost wholly wanting; the original sequence is almost hopelessly obscured by faults, folds, overfaults and inversions, while suggestions of possible unconformabilities and overlaps add to the bewildering confusion. But these eastern non-calcareous rocks contain an abundance of Graptolites fairly easy of identification, and quite as valuable chronologically as the species of Brachiopoda and Crustacea. Many of these Graptolithina have their geological dates fixed by their known horizons among the Calcareous rocks of New York and Canada; others by their known systematic places in the equivalent European succession.

In the careful study of the geographical and geological distribution of the several horizons of these Graptolites in the extensive convoluted rock series of the Eastern Townships, lies the solution of the great geological enigma of the Quebec Group and its puzzling associates. We shall not be able to parallel the eastern and western series, formation for formation, until we know more of the Graptolitic faunas of the Chazy, Black River, Trenton, Utica and Lorraine formations themselves, where they lie flat and undisturbed, and can compare them with those of their European equivalents. This is a work that ought to be at once taken up in serious earnest by American geologists, and carried on, stage by stage, with the study of the equivalent rocks of the convoluted

eastern areas. Till this is done, all our correlations of these eastern deposits must be regarded simply as provisional approximations, liable to inevitable modification and improvement in the light of future discovery. The Geological Survey of Canada possesses unequalled facilities for carrying on this work, in having both the eastern and western formations within easy reach, and both within the areas covered by the National Survey; and I sincerely trust that it is reserved for that Survey to solve the great Canadian problem of the Quebec Group in the area in which it was first propounded. It is that part of Canadian geology which is of more than national importance, and that part of American palæozoic geology which is of world-wide interest; and I shall be gratified if anything I can do or suggest will aid in advancing this great and necessary work.[1]

PROVISIONAL LIST OF FOSSILS, WITH LOCALITIES.

Slabs from Cove Fields, near Quebec City.

* Diplograptus foliaceus (*Murch.*), *vars.* 1. basilicus, 2. confertus, 3. platydens.
* " amplexicaulis? *Hall* (= Dipl. rugosus, [*Emm.*] *confr.* D. teretiusculus, *His.*)
" truncatus (?) *Lapw.*
" euglyphus, *Lapw.* (?)
Corynoides calycularis, *Nich.*
Dicellograptus, sp.
Climacograptus, two sp.
" tricornis, *Hall.*
Cryptograptus tricornis, *Carr.* (= G. marcidus, *Hall.*)
Dicranograptus tardiusculus (?) *Lapw.*

Slabs from near St. John's Market, Quebec City.

Diplograptus rugosus, *Emm.*

Half a mile above Tartigo River.

Dictyonema sociale, *Salter* (= D. flabelliforme, *Eichwald.*)

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[1] While this Preliminary Report was passing through the press, Sir W. Dawson kindly forwarded to me a copy of his Report on the Redpath Museum, McGill University, for 1883, containing an article by himself on the "Graptolites of the Quebec Group" (pp. 15-17). In this article reference is made to Mr. Weston's discovery of the Dictyonema-bearing shales at Little White River, and to Mr. Richardson's subsequent discovery of similar beds at Matane. The Dictyonema is correctly identified as the *Dictyonema sociale*, Salter, of the Upper Tremadoc (*D. flabelliforme*, Eichwald); and the inference is drawn that the containing beds are older than the typical Point Levis rocks, and are of Upper Cambrian age. It is also pointed out that certain beds associated with the Dictyonema shale contain fragments of Trilobites apparently most nearly related to those of the fauna of the Potsdam of Newfoundland. Finally, the author suggests that Graptolitic zones reaching from Lower Tremadoc to the Upper Llandeilo may ultimately be discriminated in the great mass of sediments known as the Quebec Group. It is highly gratifying to find that the original views advanced by Sir W. Dawson in 1883 are practically identical with those laid down in the present Preliminary Report.

* Same as Marsouin River, as regards species and rock.

One mile below Tartigo River.

Dicellograptus sextans, *Hall*, var.
Cœnograptus gracilis, *Hall.*
Diplograptus Whitfieldi, *Hall.*
" putillus, *Hall.* (?)
Climacograptus perexcavatus, *Lapw.*
Clathrograptus cuneiformis, *Lapw.*

Near Fox River.

Dicranograptus ramosus, *Hall.*
Dicellograptus *confr.* tenuis, *Hall.*
" sextans, *Hall* (intortus, *Lapw.*)
Diplograptus foliaceus, *Murch.*
Climacograptus *confr.* Scharenbergi, *Lapw.*
" antiquus, *Lapw.*

Between Little Fox River and Gros Maule.

Cœnograptus gracilis, *Hall.*
Diplograptus foliaceus, *Murch.*
Thamnograptus Barrandei, *Hall.*
Dicranograptus ramosus *Hall* (larger form.)

Cape Rosier.

Clonograptus, sp.
Dictyonema sociale, *Salter.*
Dichograptus, sp.

One mile below Little Michaud River.

Dicellograptus sextans, *Hall.*
Climacograptus antiquus, *Lapw.*
Lasiograptus bimucronatus, *Nich.* (mucronatus, *Hall.*)
Dicranograptus ramosus (*Hall*), *var.* spinosus, *Lapw.*
Diplograptus foliaceus, *Murch.* (= D. pristis, *Hall.*)
" euglyphus, *Lapw.*
Cœnograptus gracilis, *Hall.*

North-west Point, Griffin Cove.

Clematograptus multifasciatus, *Hall.*
Dicellograptus sextans, *Hall.*
" divaricatus, *Hall.*
Diplograptus Whitfieldi, *Hall.*
" (?) putillus, *Hall.*
Climacograptus bicornis, *Hall.*
Cœnograptus gracilis, *Hall.*

A little above the Marsouin River.

Dicranograptus ramosus (*Hall*), *var.* rectus, *Hopk.*
Dicellograptus sextans, *Hall* (slender variety.)
Lasiograptus mucronatus, *Hall* (bimucronatus, *Nich.*)

One mile east of Little Capuchin River.

Dictyonema (sociale, *Salter.*)

One mile below Little White River.

Dichograptus, sp.
Clonograptus, sp.

One mile east of Griffin Cove.[1]

Dicranograptus ramosus, *Hall* (spinosus, *Lapw.*)
Climacograptus Scharenbergi, *Lapw.*
Lasiograptus mucronatus, *Hall* (bimucronatus, *Nich.*)
Dicellograptus sextans, *Hall.*
" sextans (*Hall*), *var.* tenuibrachiatus.
Diplograptus euglyphus, *Lapw.*
" perexcavatus (?) *Lapw.*
" foliaceus, *Murch.* (acutus.)

One mile west of Grand Méchin Point.

Bryograptus, sp.
Callograptus, sp.
Clonograptus, sp.

Three miles above Ste. Anne.

Phyllograptus Anna, *Hall.*
Tetragraptus fruticosus, *Hall.*
Didymograptus extensus, *Hall.*

Gros Maule.

Diplograptus rugosus, *Emm.*

One mile west of Long Point.

Bryograptus. sp.
Clonograptus, sp.
Didymograptus, sp.
Dictyonema, sp.

[1] The backs of many of the specimens are marked "half a mile below Little Méchin River." One specimen, locality not known, affords the Bala form of *Dicranograptus ramosus*, Hall.

A little above Marsouin River.

Dicranograptus ramosus (*Hall*), *var.* rectus, *Hopk.*
" tardiusculus, *Lapw.* (ramosus.)
Dicellograptus sextans. (Slender variety.)
" intortus, *Lapw.*
Lasiograptus mucronatus, *Hall*, (bimucronatus, *Nich.*)
" bimucronatus, *Nich.* (mucronatus, *Hall.*)
Didymograptus sagittarius, *Hall.*
" *confr.* superstes, *Lapw.*
Cœnograptus gracilis, *Hall.*
Diplograptus foliaceus, *Murch.* (acutus, *Lapw.*)
Climacograptus perexcavatus, *Lapw.*

Near Little Falls, Magdalene River.

Didymograptus sagittarius, *Hall.*
Dicranograptus ramosus, *Hall.*
" *confr.* sextans, *Hall.*
Clinacograptus *confr.* Scharenbergi, *Lapw.*
Diplograptus (foliaceus, *Murch.* ? *var.*) acutus, *Lapw.*

Long Point, Ste. Anne River.

Glossograptus ciliatus, *Emmons.*

Grande Coupe and Magdalene River.

Diplograptus euglyphus, *Lapw.*
" foliaceus, *Murch.*

Island of Orleans, near Quebec City.

Dicranograptus ramosus (*Hall*), *var.* spinosus, *Lapw.*
Climacograptus Scharenbergi, *Lapw.*
" bicornis, *Hall.*
Diplograptus foliaceus, *Murch.*

Half mile up from Anse de l'Etang.

Dicranograptus ramosus, *Hall* (Nicholsoni, *Hopk.*)

Farnham, Lot 33 ? *Range* III.

Oldhamia radiata, *or* Dictyonema impression.

Half a mile above Cap Rouge.

Climacograptus antiquus, *Lapw.*
" sp.
" bicornis, *Hall.*
Diplograptus rugosus, *Emm.*
" *confr.* putillus, *Hall.*
" foliaceus, *Murch.* (pristis, *Hall.*)
Dicranograptus ramosus, *Hall* (destitute of spines.)
Dicellograptus divaricatus, *Hall.*
" intortus, *Lapw.*
" sextans, *Hall.*
Cœnograptus gracilis, *Hall.*
Lasiograptus bimucronatus, *Nich.*
" mucronatus, *Hall.*
Didymograptus sagittarius, *Hall.*

Barrasois Brook, Cape Breton Island.

Dictyonema sociale, *Salter* (= D. flabelliforme, *Eichwald.*)

TABLE A.

Showing the various Horizons, approximate Geological Age, and American and European Equivalents of the Geological Survey of Canada to Professor

EUROPEAN FORMATIONS AND GRAPTOLITIC ZONES.

	Formations in Great Britain.	Graptolitic Zones already recognised in the foregoing formations in Great Britain and Europe.
ORDOVICIAN OR CAMBRO-SILURIAN SYSTEM.	**E.** BALA OR CARADOC FORMATION. E^3.—Upper Division. E^2.—Middle Division. E^1.—Lower Division (*Bala Limestones* of Wales).	E^3.—Zone of DICELLOGRAPTUS ANCEPS, Lapworth, (Hartfell, Scotland, Sweden, Bohemia, etc.) with *Dipl. truncatus.* (UPPER HARTFELL.) E^2.—Zone of PLEUROGRAPTUS LINEARIS (Scotland, Scandinavia), with *Amphigraptus radiatus*, H., *Lept. flaccidus*, H., *Orth. quadrimucronatus*, H. (MIDDLE HARTFELL.) E^1.—Zone of DICRANOGRAPTUS CLINGANI, Carr. (Scotland, Sweden), with *D. ramosus, Climac. caudatus, C. bicornis, Dicell. Forchammeri*, etc. (LOWER HARTFELL.)
	D. LLANDEILO FORMATION. D^3.—Upper Llandeilo. D^2.—Middle Llandeilo (*Llandeilo Limestones* of S. Wales, *Craighead Limestone* of Scotland.) D^1—Lower Llandeilo.	D^3. D^2. Zone of CŒNOGRAPTUS GRACILIS, Hall. With *Dicranograptus ramosus*, var. *spinosus, Dicran. Nicholsoni, Didym. sagittarius*, Hall, *Lasiograptus mucronatus*, Hall, *Didym. superstes, Climac. antiquus, C. Scharenbergi, Dicellograptus sextans, Dipl. Whitfieldi, Leptograptus* sp., etc. (GLENKILN SHALES, etc.) D^1.—Zone of DIDYMOGRAPTUS MURCHISONI, Beck, with *Glossograptus ciliatus*, Emmons, *Climac. perexcavatus*, Lapw. (LLANDEILO SHALES, etc.)
	C. ARENIG FORMATION. C^3.—Upper Arenig. C^2.—Middle Arenig (*Orthoceras Limestones* of Sweden). C^1.—Lower Arenig.	C^3.—Zones of Ashes and Lavas of Arenig, Shelve, and Borrowdale, Cumberland. (BORROWDALE SERIES.) C^2.—Zone of DIDYMOGRAPTUS BIFIDUS, Hall. With *Didym. extensus, D. Nicholsoni, Phyll. angustifolius*, etc. (UPPER SKIDDAW.) C^1.—Zone of TETRAGRAPTUS BRYONOIDES, Hall, with *Loganograptus Logani, Didym. patulus, D. nitidus, Tetra. Bigsbyi, T. fruticosus*, etc. (LOWER SKIDDAW.)
CAMBRIAN (UPPER) OR PRIMORDIAL SYSTEM.	**B.** TREMADOC FORMATION. B^2—Upper Tremadoc. B^1—Lower Tremadoc.	B^2.—Zone of BRYOGRAPTUS KJERULFI, Lapworth, with *Clonograptus, Dictyonema*, etc. (UPPER TREMADOC SLATES.) B^1.—Zone of DICTYONEMA SOCIALE, Salter, (= *D. flabelliforme*, Eichwald) and *Clonograptus*. (LOWER TREMADOC SLATES.)
	A. LINGULA FLAGS. (UPPER.)	Zones of OLENUS SPINULOSUS and O. SCARABEOIDES.

TABLE A.—*Continued.*

several Graptolitic Zones illustrated in a collection of Graptolites forwarded March, 1886, by the Director of the Lapworth for identification and study.

AMERICAN FORMATIONS AND GRAPTOLITIC ZONES.			GRAPTOLITIC ZONES, Illustrated by recent Geological Survey collections from Quebec, Ste. Anne, Gaspé, etc.	
	Graptolitic Zones, New York State.	Graptolitic Zones, Canada.		Graptolitic Zones recognised in Strata of Quebec, Orleans Island, Marsouin River, and down to Cape Rosier, Gaspé.
HUDSON RIVER GROUP OR LORRAINE. UTICA.	E².—Lorraine Slates of New York, with *Amphigr. radiatus*, H., *D. foliaceus*, Murch. E¹.—Utica Slates of Oxtungo Creek, N.Y., with *D. pristis*, H., *C. bicornis*, H., *Dicran. ramosus*, *Didym. serratulus* (?)	E².—Utica Slate of Lake St. John, with *Leptograptus flaccidus*, *Orth. quadrimucronatus*, etc. E².—Utica Slate of neighbourhood of Ottawa, with *Lept. flaccidus*, *L. annectans*, *Dipl. pristis*, *Climac. bicornis*, etc.	UTICA AND HUDSON RIVER GROUP. LORRAINE.	E¹.—GRAPTOLITIC SHALES of Citadel Hill, Quebec, St. John's, Nfld., and N. end of Orleans Island, with *Diplograptus foliaceus*, Murch. (*var. β*), *Climac. bicornis*, H., *Dicran.*, sp., and *Corynoides calycularis*.
BLACK RIVER AND TRENTON.	D³.—Graptolitic Shales of Normanskill, near Albany Valley of Hudson River, with *Dicran. ramosus*, *Dicell. furcatus*, *Didym. serratulus*, H., *Dipl. mucronatus*, *Dicell. sextans*, *D. divaricatus*, H., *Climac. bicornis*, *Crypt. marcidus*, H.	D².—Graptolitic Shales of Marsouin River, with *Dicran. ramosus*, H., *Didym. serratulus*, H., *Dicell. sextans*, H , etc.	BIRDSEYE AND TRENTON. POST-LEVIS. PRE-UTICA (?)	D³ D² CŒNOGRAPTUS Zones. Shales of Griffin Cove, Marsouin River, Little Méchin River, Cap Rouge (Quebec), Fox and Magdalene Rivers, etc., with *Didymograptus sagittarius*, H., *Lept. tenuis*, H., *Cœn. gracilis*, H., *Dicell. sextans*, H., *D. intortus*, Lapw., *Dicranogr. ramosus*, H. (vars.), *Lasiogr. mucronatus*, H., *Dipl. Whitfieldi*, H., *Dipl. foliaceus*, Murch. (vars.)
CALCIFEROUS AND CHAZY.		QUEBEC GROUP OF LOGAN. C². C¹. Graptolitic Shales of Pt. Levis, with *Loganograptus Logani*, *Clon. rigidus*, *Phyll. Anna*, *P. typus*, *Tetra. bryonoides*, *T. fruticosus*, etc.	CHAZY. LEVIS.	C¹*b*.—PHYLLOGRAPTUS Zone. Shales of Ste. Anne River (three miles above) with *Phyll. Anna*, H., *Tetragr. fruticosus*, H., *Didym. extensus*, H., etc.
			PROBABLY OF CALCIFEROUS AGE. QUEBEC. LEVIS.	B¹.—DICTYONEMA SOCIALE Zone (A). Shales of Cape Rosier, Little Whale River, Grand Méchin Point, with *Bryograptus*, sp., *Staurograptus*, *Clonograptus*, *Dictyonema sociale*, Salt. DICTYONEMA Zone (B). Shales of Barrasois River, Cape Breton Island, with *Dictyonema sociale*, Salter, and *Olenidæ*. OLDHAMIA Zone. Purple Shales of Farnham, with *Oldhamia*, sp., like *O. radiata*.

TABLE B

SHEWING VERTICAL RANGE OF GRAPTOLITES FROM ROCKS BETWEEN CAPE ROSIER (GASPÉ) AND CAP ROUGE (QUEBEC).

	Barrasois River, Cape Breton.	Cape Rosier, Gaspé.	Half a mile west of Long Point, Ste. Anne's.	Little White River.	Half a mile above Tartigo River.	Half a mile east of Little Capuchin River.	One mile west of Grand Méchin Point.	Three miles above Ste. Anne River.	Long Point, Ste. Anne.	Anse-à-l'Etang.	Gros Maule.	One mile east of Griffin Cove.	A little above Marsouin River.	One mile below Tartigo River.	North-west Point, Griffin Cove.	One mile below Little Méchin River.	Near Fox River.	Little Falls, Magdalene River.	Grande Coupe de la Magdalene River.	Between Little Fox River and Gros Maule.	Half a mile above Cap Rouge.	Island of Orleans, north-west shore.	St. John's Market, Quebec.	Cove Fields, Quebec.
Dictyonema sociale, *Salter*	*	*	*	..	*	*	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	.	..	..
Clonograptus, sp.	..	*	..	*	..	..	* *	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bryograptus, sp.	..	..	*	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Dichograptus, sp.	..	*	*	*	..	..	..	..	..	...	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Phyllograptus Anna, *H.*	..	..	..	..	..	..	..	* *	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Tetragraptus fruticosus, *H.*	..	..	..	..	..	..	..	* *	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Didymograptus extensus, *H.*	...	..	?	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
" sagittarius, *H.*	...	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	*	...	..	*	..	..	..
" superstes? *Lapw.*	..	..	..	..	..	..	..	..	..	..	..	..	*	..	..	...	..	..	..	..	..	..	..	..
Clematograptus multifasciatus, *H.*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..
Cœnograptus gracilis, *H.*	..	..	..	..	..	..	..	..	..	..	..	..	*	*	*	*	..	..	..	*	*	..	..	..
Dicellograptus sextans, *H.*	..	..	..	..	..	..	..	..	..	..	..	*	*	*	*	*	*	*	..	..	* *	..	..	..
" divaricatus, *H.*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	* *	..	..	..
" intortus, *Lapw.*	..	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	*	..	..	..
Dicranograptus ramosus, *H* (spinosus)	..	..	..	..	..	..	..	..	..	*	..	*	*	..	..	*	..	*	..	*	*	*	..	..
* " *var.* tardiusculus, *Lapw.*	..	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	*	..	..	..	..	..	..	*
Glossograptus ciliatus, *Emm.*	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
* " Hincksii? *Hopk.*	...	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Lasiograptus mucronatus, *H.*	..	..	..	..	..	..	..	..	..	..	..	*	*	..	..	*	..	..	..	..	*	..	..	..
Clathrograptus cuneiformis, *Lapw.*	..	..	..	..	.	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..
Diplograptus Whitfieldi, *H.*	..	..	..	..	..	..	..	..	..	..	..	..	..	*	*	..	..	..	..	..	..	..	..	..
" marcidus? *H.*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	?
* " rugosus, *Emm.*	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	*	.	?	..
" euglyphus, *Lapw*	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	*	..	..	*	..	..	..	..	*
* " putillus, *H.*	..	..	..	..	..	..	..	..	..	..	..	..	..	*	*	..	..	..	..	..	?	..	..	..
* " amplexicaulis, *H.*	...	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	?	..	..	*
" foliaceus, *Murch*	..	..	..	..	..	..	..	..	..	..	..	*	*	..	..	*	*	*	*	*	*	*	?	*
* " truncatus? *Lapw.*	..	..	..	..	.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*
Climacograptus bicornis, *H.*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	*	*	..	*
" Scharenbergi, *Lapw.*	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	.	*	*	..	..	?	*	..	..
* " antiquus, *Lapw.*	..	..	..	..	..	..	...	..	..	...	..	?	*	*	..	*	*	..	..	..	*	..	..	..
Corynoides calycularis, *Nich.*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*
Thamnograptus, sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..
	Cape Rosier or *Dictyonema sociale* Zones.							Levis Zone.	Marsouin Zones. *Cœnograptus* beds.													Cove Fields. Zones destitute of *Cœnograptus.*		

NOTE.—The species to whose names an asterisk is prefixed are only provisionally identified.

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Fig. 1. Davallia tenuifolia. Fig. 2. Equisetum (root.) Fig. 3. Thuja interrupta. Fig. 4. Fruit of the same. Fig. 5. Taxites Olriki. Fig. 6. Lemna scutata. Fig. 7. Platanus nobilis (reduced). Fig. 8. Castanea. Fig. 9. Populus arctica, *var.* Fig. 10. Salix Laramiana.

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Fig. 11. Ulmus præcursor. Fig. 12. Sassafras Burpeana. Fig. 13. Sassafras Selwynii.
Fig. 14. Viburnum Calgarianum. Fig. 15. V. oxycoccoides. Fig. 16. Aesculus antiqua.
Fig. 17. Symphorocarpophyllum Albertum. Fig. 18. S. Linnæiforme.
Fig. 19. Trapa borealis. Fig. 20. Phyllites.

Note.—Fig. 14. This species is near to *V. Nordenskioldi*, Heer. Figs. 15 and 19 (b.) are partially restored.

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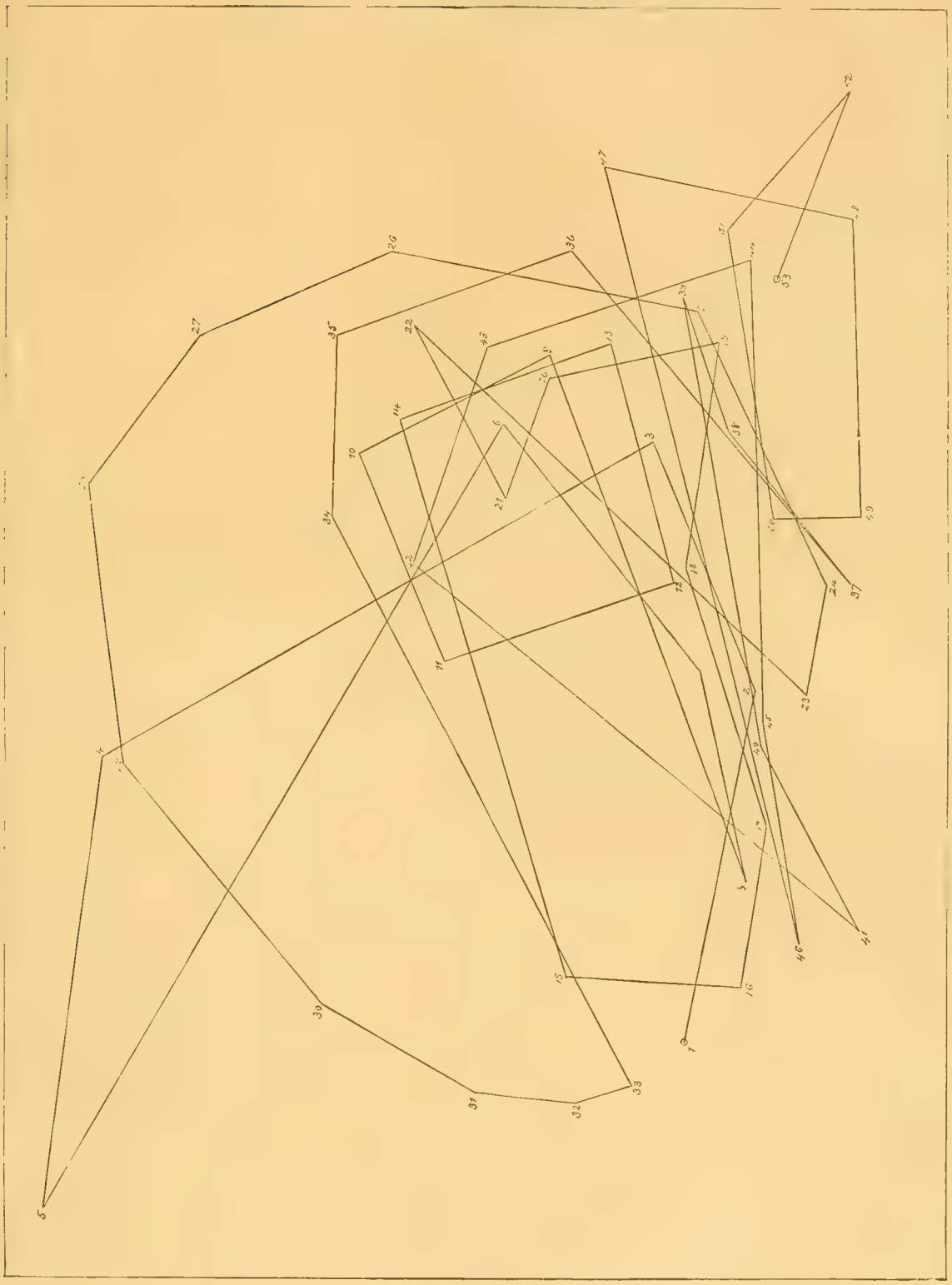

To illustrate Prof. Penhallow's paper on the Mechanism of Movement.

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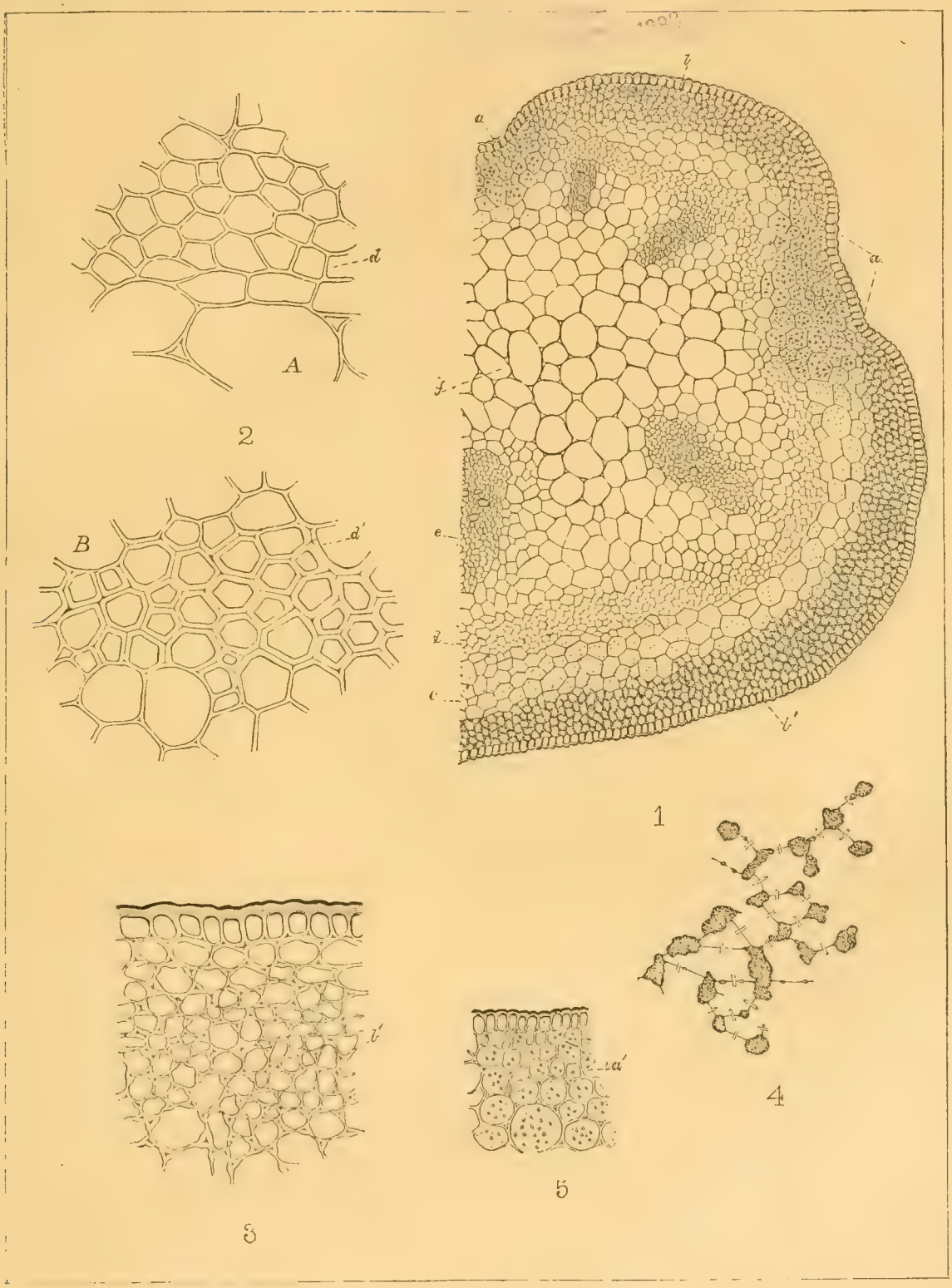

To illustrate Prof. Penhallow's paper on the Mechanism of Movement.

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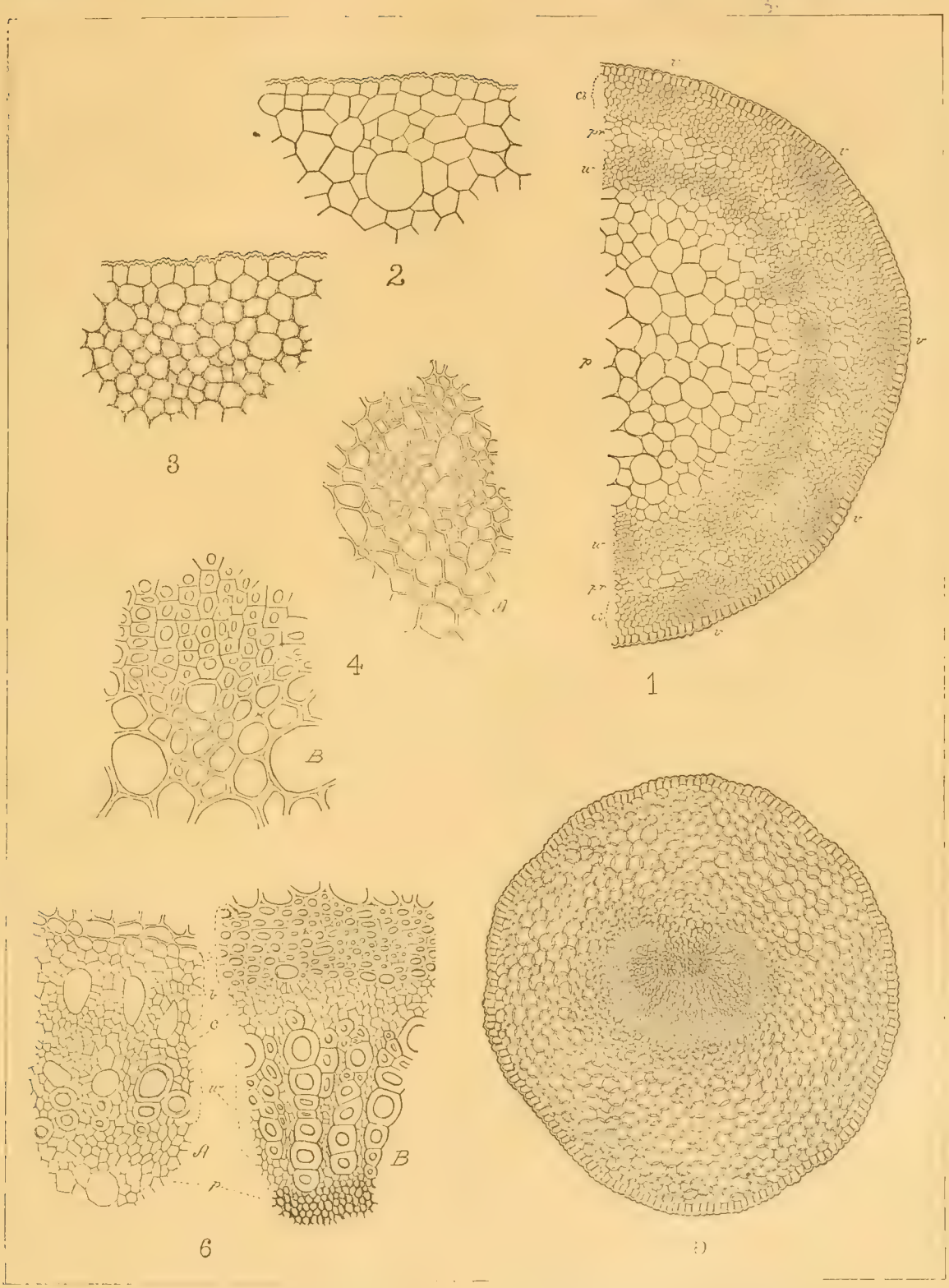


To illustrate Prof. Penhallow's paper on the Mechanism of Movement.

FIG. 3.

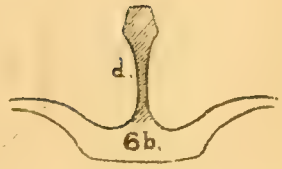


FIG. 2.

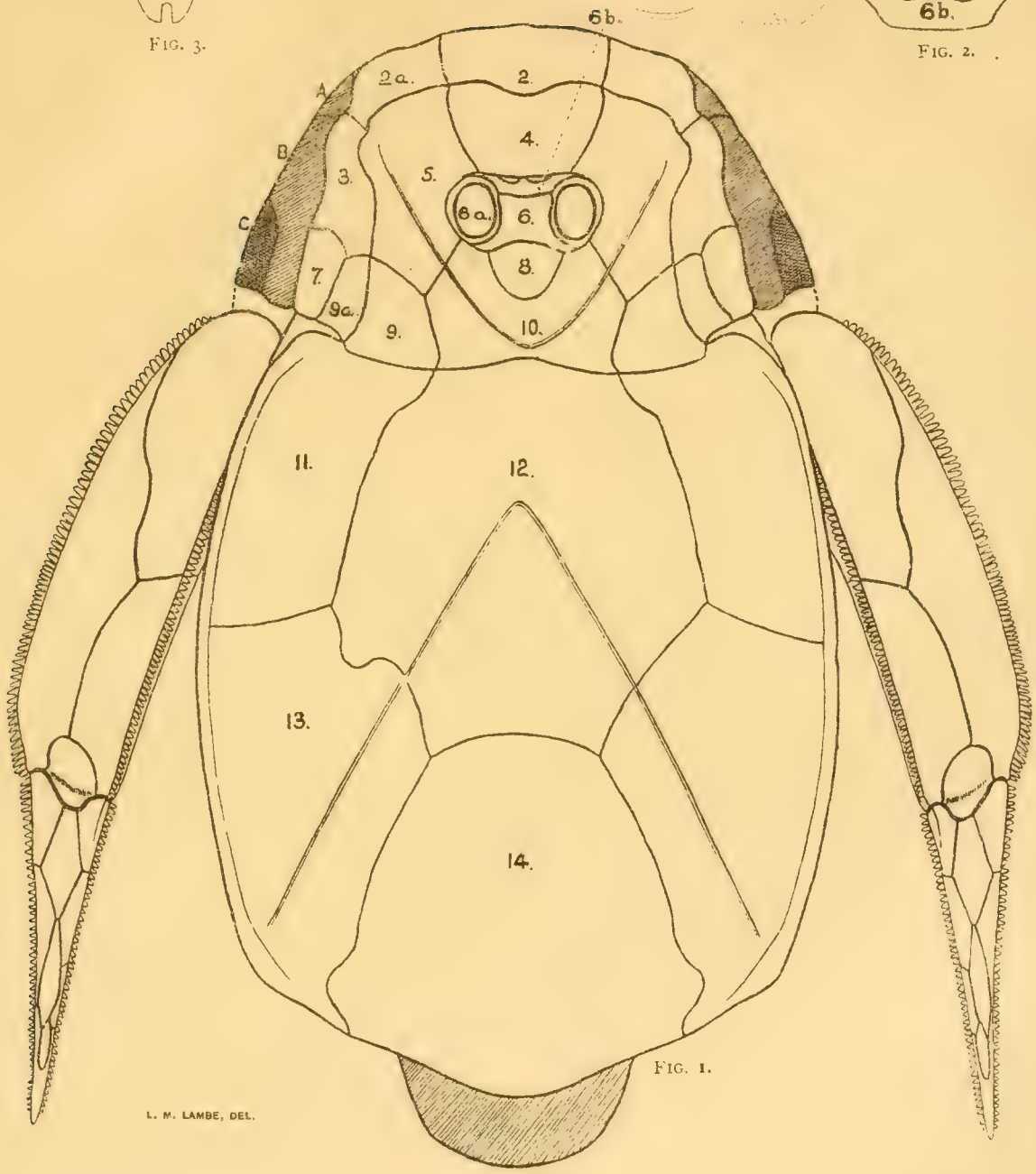


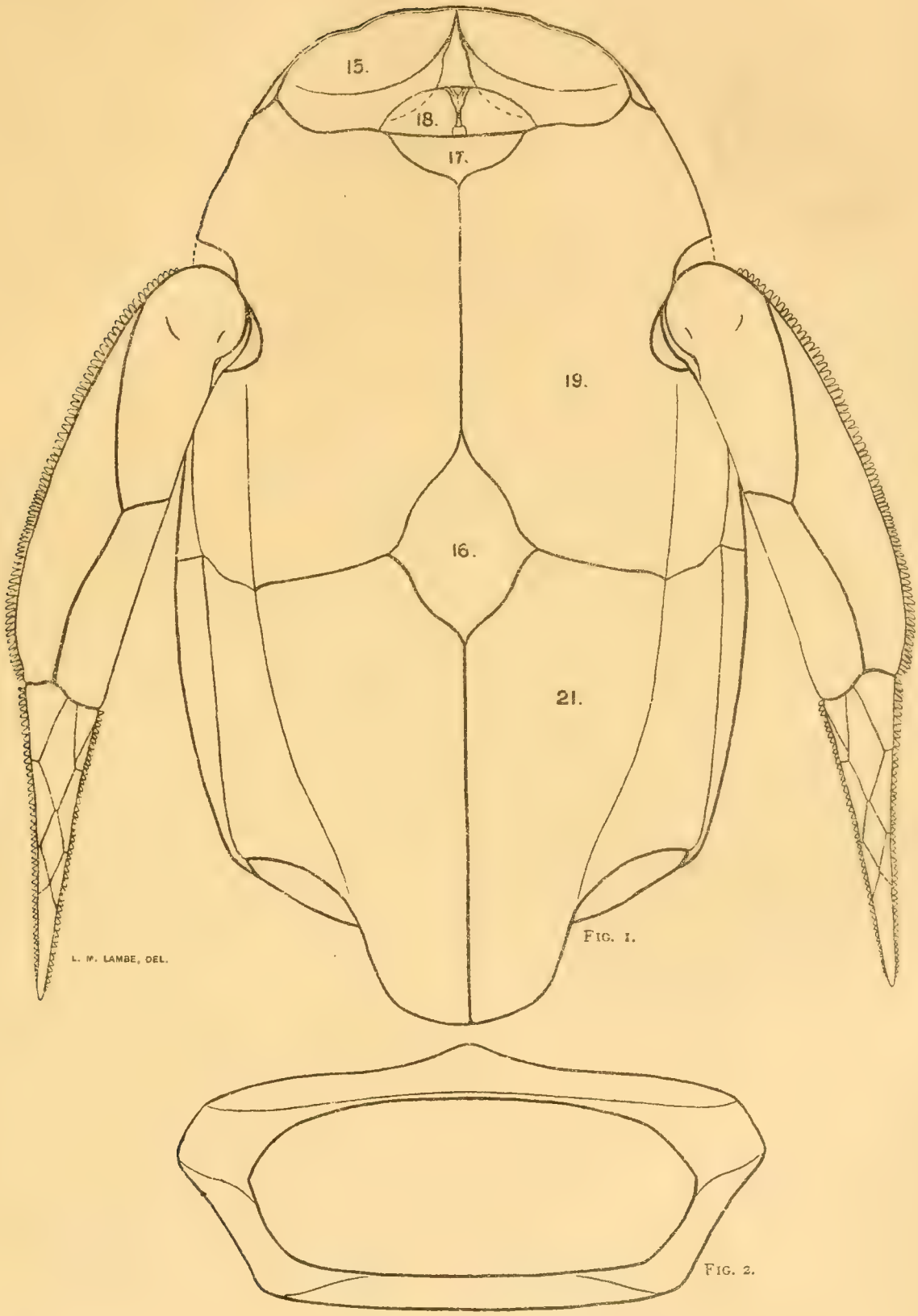
FIG. 1.

PTERICHTHYS (BOTHRIOLEPIS) CANADENSIS, Whiteaves.

FIG. 1.—Upper surface, to show the shape and arrangement of the plates, the sculpture being purposely omitted. The numbers on the plates correspond as far as practicable to those of Pander's restoration of Pterichthys.

FIG. 2.—Enlarged representation of Plate 6*b*, the shaded portion being intended to show its downward deflection.

FIG. 3.—Posterior articulating or semi-articulating surface of the cranial shield as viewed from below.



PTERICHTHYS (BOTHRIOLEPIS) CANADENSIS, Whiteaves.

FIG. 1.—Under surface to show the shape and arrangement of the plates.

FIG. 2.—End view of the combined dorsal and ventral body shields in outline as seen from behind. The inner continuous line represents the tail opening.

PTERICHTHYS (HOTHRIOLEPIS) CANADENSIS, Whiteaves.

Upper surface of a specimen in which the pectoral spines are not preserved. Natural size.

ARTOTYPE, PATENTED; CANADA BANK NOTE CO., LIMITED, MONTREAL

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PTERICHTHYS (EUTHRIALEPIS) CANALENSIS, Whiteaves.

Lower surface of a specimen in which the pectoral spines are preserved. Natural size.

ARTOTYPE, PATENTED; CANADA BANK NOTE CO., LIMITED, MONTREAL

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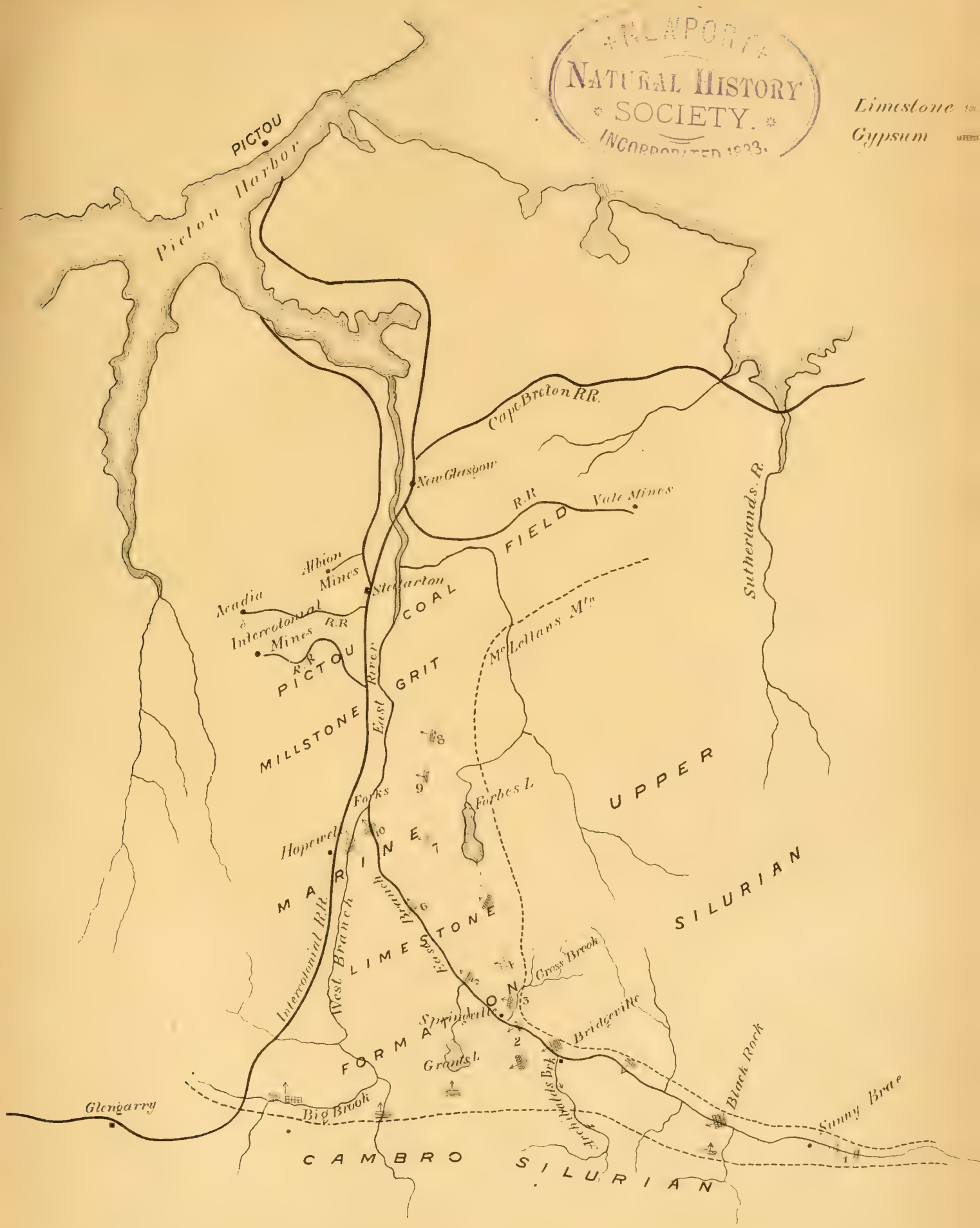
L. M. LAMBE, DEL.

Fig. 1.—ACANTHODES CONCINNUS.—Specimen in which the head is not preserved, nat. size. (*1a*). Scales from body of same, highly magnified.

Fig. 2.—PHANEROPLEURON CURTUM.—One of the original types of the species, nat. size. (*2a*). The largest individual known, one third nat. size, and shewing the lobate ventrals and one pectoral. (*2b*). Cranial plates. (*2c*). Palatal teeth. (*2d*). Scales, all nat. size. (*2e*). An isolated scale, enlarged, of the same.



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